JOURNAL

OF

THE MINING SOCIETY

OF

NOVA SCOTIA.

VOL XI.

Being the Transactions of the Society during the
Year 1906–7.

The Transactions for the Years 1895-6, 1896-7, and 1897-8, will be found in
the "Journal of the Federated Canadian Mining Institute,"
Vols. I, II and III.

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PAPERS

TRANSACTIONS

OF

The Mining Society of Nova Scotia.

The Society as a body is not responsible for the opinions and views expressed in the several papers published in the Transactions.

Vol. XI. Session 1906-07

The Relation of Technical Education to Industrial Progress.

By Prof. Frederic H. Sexton, Dalhousie College, Halifax.

(Read 22nd March, 1906.)

I wish to bring to your attention a matter which is today of vital importance to the welfare of the province of Nova Scotia. There has been much written of late about technical education, and there would seem little excuse for opening the subject again. My excuse lies in the fact that I have found in every day contact with the people around me, that they do not realize the educational and industrial conditions in other countries, and especially do not realize the intimate relation between technical education and industrial progress. This most important phase of the question has been neglected in most of the papers prepared especially for Nova Scotian readers. Therefore, I bring this subject, "The Relation of Technical Education to Industry," to your earnest consideration.

For the reason that a man engaged in a special calling is likely to be biassed in that specialty, so that he cannot state its aspects in their true color and proportion, I do not intend to inflict my personal opinions upon you, but the opinions of eminent men, gathered from different sources. There is no need for me to voice my own thoughts, because so many who have searched keenly and thought broadly and deeply have said so often the truths I wish to bring to your notice.

Progress of chemical industry in Germany.—Let us turn to the conditions existing in Germany. I choose Germany because she was the pioneer, and still stands pre-eminent in applying science to industry. She has led and the rest of the world is following. She is noted especially for her gigantic chemical industries and it is in this phase that I wish you would especially consider her. Dr. Henry S. Pritchett has recently stated her position thus:—

"In 1870, the manufactures, the inventions, and the foreign commerce of the separate German states were far below those of England and of France. To-day United Germany stands in the front rank of the nations of the world in industrial productions, and she clearly leads all other nations in the applications of science to industry and to the arts. Her position is all the more remarkable because this result has been achieved in a country in which the agricultural and mineral resources are are not great, and in the face of the burdens due to long and costly wars, to maintenance of a great army, and to the draining of a large part of its population. One of the important factors has been the systematic development of scientific research and the application of research to the practical industrial problem of the nation."(1)

Dr. Frederick Rose in a luminous consular report shows clearly that in each case where a large manufacturing process has been developed, it resulted from, first, some scientific discovery due to research, and second, the commercial application of that discovery. He encourages us also by saying, "Germany is not better adapted than other countries for the foundation of great chemical industries except, perhaps, that she is richly endowed with springs and rivers."(1) This seems a diminutive asset, indeed for the foundation of such great progress. Surely Nova Scotia is bountifully blessed in this respect.

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(1) How Science helps Industry in Germany H. S. Pritchett. Am., Rev. of Revs., Feb. 1906, XXXIII, p. 193.

Now the basis of Germany's chemical industry was laid in the little apothecary shops 250 years ago. They grew until they became small chemical factories and produced a constantly increasing demand for acids, soda, etc. The competition of British products was very keenly felt, until simply by the progress of scientific research, education and, and the application of science, fostered by the government, she, Germany, outstripped the world in chemical industry.

I wish now to call your attention to several notable discoveries and to show a very few of the far reaching trains of results.

"In 1840, Justus von Liebig proved that if soils are not to become impoverished those salts of which they are deprived by agriculture must be restored to them in the form of manure."(2) Thus he laid the foundation of the phosphate-manure industry together with an inestimable benefit to agriculture itself. Beside founding a large branch of chemical industry, these facts were instrumental in the discovery and working of the Prussian salt mines at Stassfurt, of the Anhalt salt strata, of the discovery and mining of immense beds of apatite and salpetre, and pyrites for sulphuric acid. Truly the train of results from this scientific research was of incalculable industrial result. The mines at Stassfurt and Anhalt produced from 1860-1890, an amount valued at $57,500,000.

(1) Chemical Instruction and Chemical Industries in Germany. Dr. Frederick Rose, H. M. Consul at Stuttgart. Diplomatic and Consular Report No. 561, Miscellaneous Series, July, 10, 1906, p. 41.

(2) Rose Ibid. p. 43

"Liebig's investigations may be considered as having principally contributed to the working of the Chilian saltpetre deposits.

Total export of saltpetre from South America.

Year	Tons
1940	11,368
1850	25,292
1860	68,521
1970	147,172
1880	226,090
1890	1,033,100

The last amount was valued at $40,000,000. (1)

The beet sugar industry is now one of the greatest in the world. The basis of this industry was laid in Germany, and while it has been assisted in development by protective tariff, it has chiefly prospered by increased economy from scientific investigation and by increasing the scale of working.

Year	Production of Raw Sugar	% of Sugar yielded from Beet
1840	8,822	5.72
1850	35,709	7.22
1860	128,141	8.17
1870	210,915	8.30
1880	418,010	8.93
1890	1,110,703	12.73
1899	1,664,677	13.00

The third column shows the continually increased extraction indicating, in a rough way, the stricter scientific economy. (2)

Germany has lately been instrumental in developing the tremendous modern coal-tar industry. In the early days of gas-making the tar was a great nuisance, because there was no use for it, and it was difficult to dispose of. Investigators worked diligently with it, however, and it was found that by fractional distillation, the unpromising black sticky mass, could be separated into almost an infinite number of valuable compounds. The chief distillates are roughly, naphtha and benzine, carbolic oil and naphthalene, creosote oil and anthracene oil, and pitch. Every product is used for the manufacture of other products and is completely consumed in the Arts so that nothing is wasted.

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(1) Rose, Ibid. p. 43

(2) Rose, Ibid., p. 51.

The anthracene oil is used for the production of the coal tar dyes, and is the most important constituent of the coal tar. At the present time there are several thousand dyes on the market, all of which have been developed in a comparatively short time from one of these constituents of coal tar, aniline, phenol, quinoline or anthracene. The large German manufacturers employ hundreds of trained organic chemists whose sole duty is to try unceasingly to discover new colors.

"In 1898, the total estimated value of the manufacture of organic dyes in Germany was $30,000,000."(1)

For nearly thirty years some of the most eminent German chemists labored to manufacture indigo artificially by the synthesis of cheap organic compounds. Finally, they achieved the looked for result, and this itself more than paid for the thousands of dollars and the years of labor, but besides, they discovered the contact process for the manufacture of sulphuric acid, which promises to revolutionize the manufacture of this staple product, and they also discovered other important things in the same research.

A further triumph of organic chemical research work has been the discovery and manufacture of artificial perfumes, again principally by German chemists.(2)

(1) Rose, Ibid., p. 56.

(2) Rose, Ibid., p. 60.

"The total value of the production of the German chemical industries in 1897 amounted to about $237,000,000, and now, 1905, must be at least ¼ greater. These are huge figures for an industry which is only ¾ of a century old, and they may be considered as the interest accruing from the capital invested by the State in chemical instruction. The amount of national wealth created by the German chemical industries assumes a still more striking significance when it is taken into consideration that the advance of chemical knowledge in Germany has enabled her in many instances to export chemical products which she was formerly compelled to import, or, in other words, to receive money from abroad instead of disbursing it, creating at the same time new sources of home employment." (1)

"There are few branches of human industry for the successful prosecution of which chemical science in some form or other not of paramount importance

If this essential fact were only adequately appreciated it would be realized that those countries which possess the greatest number of and the best trained chemists will, if the further necessary conditions are given, in course of time become the richest and most powerful. They will possess the best foodstuffs, materials and products and will combine the greatest economy in use, with the maximum amount of production, and they will be best fitted to avail themselves to the full of their natural resources and thus be enabled to render themselves as far as possible independent of other nations." (2)

I think we will all admit by this time that Germany has made marvellous progress and that scientific research was an all-important factor in her success. Now how has she fostered this spirit of research? I answer, in her colleges, in laboratories supported by the large manufacturing firms, and by

(1) Rose, Ibid., p. 71.

(2) Rose, Ibid., p. 74.

well equipped Government Technical Schools and testing laboratories.

Royal testing office of Germany.—The German government has realized fully the value of technical education, and they show their appreciation by stimulating and aiding it each year. Germany's "unique national development of industrial research can be appreciated in no better way" than to outline the scope of the Royal Testing Office (Das Konigliche Material prufungsamt) supported by the government. This institution began thirty-five years ago in a modest shop adjoining the engineering school of Charlottenburg and which has within the last two years been transferred to a new and magnificent series of buildings at Gross Lichterfelde, just outside of Berlin, where enough room can be had for indefinite expansion in the future.

"The tests and investigations undertaken by the experimental establishment at Charlottenburg fall into two general groups, mechanical and chemical. These tests were intended at the beginning to serve the double purpose of instructing students and of developing practical results. At the beginning, the tests of metals were the most numerous and important. These consisted in determining not only the hardness and the tensile strength, but the behavior of the beam of steel, for example, under a load, the chemical changes which might take place under varying conditions, and the conditions for maximum strength and cheapness of construction. The meaning of this establishment, with its experts and laboratories, may be better understood perhaps by indicating briefly some of the problems which are solved in it.

A manufacturer who has a problem on his hands which he finds difficult of solution can at a very modest expense bring this to the research laboratory, where it will be not only attacked by the experts of the establishment, but the experts of the firm may also work side by side with those of the government on the common problem. The advantage which is thus afforded to the manufacturer can hardly be overestimated and he finds in the government establishment not only a corps of skilled and enthusiastic experts, but he finds also all the literature of the subject brought together for use and ready at hand for convenient reference. The problem may be studied in the light of all that is known on the subject, and starting from the point of the world's knowledge rather than to go through the tedious plan of trying out methods already discarded elsewhere. A paper manufacturer in Berlin, in illustrating the the benefits of the research establishment, told the following story from the experience of his own firm: "Some years ago," said he, "we began to draw our wood supply from a new source and the wood-pulp made therefrom no longer complied with the conditions of the trade. Our business began to decline, and seemed likely to disappear altogether. In this emergency we took our problem to the National Testing Laboratory, and in the division for paper-testing it was taken up. Not only were the experts of that division put up to work upon it, but our own experts were allowed to work with them. The result of this was that at end of six months or a year our problem was completely solved and our business changed from a losing one to a paying one."

The aim has been, on the whole, to establish an institution in which a body of experts thoroughly familiar with the facilities and the literature of modern science shall be ready to turn themselves at any time to the solution of any practical problem which the inventor, the manufacturer, the metal-worker, the farmer, or the builder may bring to them.

Any citizen or any firm may, at modest cost, bring to this laboratory a technical problem and obtain the assistance of the highest expert skill in its solution, or in its explanation. Scientific research, in a word, has been harnessed effectively and skillfully to national development. It is this fact which has for us, (the United States) an industrial nation, the greatest significance, for we, too, must learn to harness it effectively and systematically to the service of industry and of manufacture. The great private establishments are installing and maintaining research laboratories for the solution of their own special problems, and perhaps it is in these latter that the conditions for real research are most favorable." (1)

In spite of all these facts we read that "chemical industrial circles in Germany are by no means satisfied with the great progress and measure of success already attained, but are actively endeavoring not only to maintain but to increase the present facilities for technical education." (2)

The government seems open and ready to provide all adequate facilities for the extension of technical education. In 1805 Prussia expended $71,000 for six universities; in 1899 this sum had increased to $1,225,000 for eight universities. In 1900 compared with 1820, the expenditure for universities has increased ten fold, and compared with 1870, almost three fold. In 1903-1904, Germany expended a total of more than $12,000,000 on technical education.

The United States every year is spending millions of money on her U. S. Geological Survey and Department of Agriculture. Has it paid? I think everybody will agree that it has, and that the past history warrants larger future expenditure. It was through the splendid efforts of the survey that the extent of the wonderful iron deposits of Michigan and Minnesota was indicated. These great iron ore deposits have made possible the enormous development of the iron and steel industry in the United States, one of the most colossal industries of modern times. The following figures indicate roughly the increase of production of steel in the United States:—

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(1) How science helps industry in Germany. Henry S. Pritchett. Am. Rev. of Revs., Feb., 1906, Vol. XXXIII, pp. 167—170.

(2) Rose, Ibid., p. 23.

Year	Production of Steel in Tons.
1870	68,750
1875	389 799
1880	1 247,335
1885	1,711,920
1890	4,277,071
1895	6,114,034
1900	10,188,329
1901	13,465,595

This increased production was also made possible by the application of science to the extraction of iron from ore and its conversion to steel. Science not only found out how to make pig-iron and steel, but it also found the ore from which they could be made. Research and mechanical genius have also had a great part in pushing the figures higher and higher until we wonder were they will stop. Every steel works has its chemists, metallographists, civil engineers, etc., who are there simply to assure economy and a high standard of products. It is very significant that Andrew Carnegie, the type of successful steel-maker, believes so thoroughly in research that he has among other things given $10,000,000 to found the Carnegie Institution of Washington, of pure research, and has also given enough money to the Iron and Steel Institute of Great Britain to found a generous scholarship for research simply in iron and steel. The following extract from a recent editorial will give one an idea of the kind of work the Carnegie Institution is doing:—

"The Carnegie Institution is a university in which there are no students and in which all the faculties are investigators. From its year-book of 1905, just published, an idea may be gained of the wide scope and great prospective value of the researches which are being conducted in this university of scientific workers. The present policy of the institution is to provide for large and continuous investigations, which might not otherwise be carried out, rather than to give a great number of individual grants. The reports for the last year show that the work undertaken is of wide range and along many different lines of scientific promise. It also shows how the purely scientific and theoretical line of investigation runs parallel with the line of utility, and that at almost any moment points of contact may be made between them. Among the larger projects, we notice the work planned for the study of plants which are fitted to live in the deserts, together with the aid to be given for five years in furtherance of Mr. Luther Burbank's already fruitful experiments in horticulture. The practical value to be expected from these plans may be judged by the statement in Mr. Burbank's report that already some large groups of cacti have been developed which produce enormous quantities of nutritious food for all kinds of stock and poultry; and a great number of new varieties of plants are under cultivation, such as 10,000 new apples, 1,000 new grape vines, and 10,000 new hybrid seedling potatoes. Researches also relating to the formation and constituents of rocks and metals promise valuable returns. Special interest attaches to the new studies concerning nutrition, to the aid of which this institution is now contributing, and which are of important psychological value, affecting as they do the economic problem of the support of the population, and also having personal relation to the working power and health of the individual. It has also equipped a vessel for observations in the the North Pacific Ocean on terrestrial magnetism—the beginning of a plan of importance for a magnetic survey of the whole world. Some of the studies which are thus being promoted in different but closely related fields will push further back the boundaries of human knowledge, and will enable us to understand better the factors and laws of evolution and to peer still further into the wonderful mysteries of the beginnings and elements of things. In providing for this great amount of original research in these and other departments of investigation, the Carnegie Institution, under the broad and far-sighted plans of its trustees, already is proving itself to be a great benefaction, not only to science, but to progress in the mastery of nature for man's welfare"(1)

"The following are instances of the way in which the investigations and reports of the U. S. Department of Agriculture have benefitted the agricultural industry of the country. [These figures were quoted in 1902]

1. Beet.—National crop increased from 8,000 to 400,000 tons in consequence of the publication by the department of a research map showing the districts in which it could be profitably grown.

2. Macaroni Wheat.—Introduced 3 years ago by the department. Crop, first year, 35,000 bushels; second year, 2,000,000 bushels; third year, 10,000,000 bushels.

3. Rice.—Introduced six years ago. Crop now 400,000,000 lbs. Land formerly 50 cts. per acre, now $50 00 " (2)

I could go on *ad infinitum* multiplying instances where large sums of money have been spent on practical research and quick and enormous industrial returns gained from the application of the knowledge obtained, but I think I have quoted enough to prove my point.

The Attitude of Manufacturing Firms to Science.

One of the most salient signs in these times of strenuous industrialism, is the changed attitude of manufacturing firms to the graduate of the technical school and college. The importance of the thoroughly trained scientific man in industry is appreciated with more force in each succeeding year. The colleges are turning out more graduates each year, but still the demand is far greater than the supply. Prof. Ayrton of the Mosely Commission, notes with keen interest the attitude of the large electrical firms toward college students. He quotes the

(1) Outlook, 1906, March 24, lxxxii, 630.

(2) Prof. H. R. Reichel, Reports of the Mosely Educational Commission to the United States of America, Oct.-Dec., 1903. London, 1904, p. 293.

chief electrician of the Westinghouse Electrical Manufacturing Co. as saying: "The Westinghouse works are the product of the colleges of this country. We have come to rely on college men; we are now practically all college-bred men ourselves. And yet, when I came to Pittsburg and knocked at the side-door of a factory, the fact that I was a college man counted against me in the mind of the superintendent. Now the same firm sends each year to the technical schools, asking for their best men, and sometimes during one yearly visit we take the whole class from a college."

Prof. Ayrton says after this: "Example after example I saw of the college and factory going hand-in-hand. At the General Electric Co. the same scheme is carried out, and each year two high officials of the company visit all the important colleges as far west as Illinois and Ohio to see the men who contemplate going into practice, so that they may choose each year 150 bright college youths of colleges of high standing." (1)

"Of 118 engineers on the staff of the Rapid Transit Railroad Commissioners of New York City, who are constructing an underground railway at a cost of $20,000,000 - $30,000,000, eighty-four per cent. had been college students." (2)

Allow me to quote from Prof. M. Maclean, of the Mosely Commission. 'One employer said: 'In all departments where high-class work is done, we pay good wages and are always anxious to get technical men. They are broader minded, and have a wider mental grasp than the man who left school to learn his trade in a shop. In technical or any other kind of work the young man who has been trained in a technical school very soon overtakes and outstrips the man who has had practical experience only. Their remuneration at first is no greater than that of others who do similar work, but in almost all cases t increases more rapidly, and there is practically no limit to

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1) Prof. W. E. Ayrton, Report of Mosely Education Commission, p. 28
2) Mr. R. Blair, " " " " p. 59

their promotion, while the man without technical educatio unless in exceptional cases, finds his field of operation greatl restricted.' Ten years ago manufacturers would not take college men, now they prefer them, because they can tackle new problems. Manufacturing processes are constantly developin and there is room for men with new ideas." (1)

"In Montreal the C. P. R. and Grand Trunk Railway Companies, and a few less important lines, are establishing a department of railway engineering, at their own cost, in McGill University, with the express object of enabling them to open up more rapidly the great north-western territories of Canada. Thomas Shaughnessy, manager of the C. P. R., said: 'In ideal railway management every office on the line requiring effective brain-work should be filled by college graduates.' Mr. Shaughnessy is not a college man himself." (2)

Mr. A. J. Shepheard, of the Mosely Commission, says: "It will be found that hundreds of fully equipped and well-grounded young men are turned into the businesses of the United States every year. This is a great advantage to the students themselves; but looked at from a general point of view, it is of immense importance to the welfare of the country generally. I believe that England is at a distinct disadvantage when the business aspect of education is considered. Where we turn out ten highly qualified men they turn out hundreds, and their trade reaps corresponding advantage."(3) Mr. Shepheard is an Englishman.

Condition in England and Attitude of Mosely Commission.

England has only lately awakened to the importance of technical training and she has only been awakened with great difficulty and a good many hard knocks. The clearest, truest, statements were made by members of the Mosely Commission.

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(1) Prof. F. Maclean: Report of Mosely Commission, p. 238.
(2) Prof. H. R. Reichel: " " " p. 308.
(3) Mr. A. J. Shepheard: " " " p. 358.

The instigator, Mr A. Mosely, a practical English business man, was impressed with the combination of engineering knowledge and business ability of two American engineers, Gardner Williams and Louis Seymour, who were so instrumental in building up the gold and diamond mines in South Africa. Mr. Mosely was so interested in the country from which these men came and the conditions obtaining there, which could produce such men, that he went to the United States himself. After studying the educational and industrial systems somewhat, he became aware that England had much to learn from the United States. Accordingly he returned home and collected a large commission of experts, who all went over to America to analyze the existing conditions and report. From their report I have culled a few remarks. Remember that these consist of advice from patriotic Englishmen to patriotic Englishmen.

Mr. Mosely says, "Looking into the future of our own country, I feel bound to record my belief that the regime of the past, however successful it may have been, is obsolete. Honesty, doggedness, pluck, and many other good qualities possessed by Britons, though valuable themselves, are useless to-day, unless accompanied by practical up-to-date scientific knowledge and such knowledge only becomes possible with an enlarged and enlightened system of education, such as the United States possesses. I feel that if we are to hold our position as the dominant nation, or one of the dominant nations of the world, we cannot afford to lag behind in educational matters as we are now doing.

"I am convinced that if the British Empire is to hold its own, our old industrial methods will have to be dropped, and especially our present method of popular education will have to be changed. Enormous strides are being made by the United States with its truly wonderful natural resources to draw upon. On the other hand, Germany is also making great strides, has not such natural advantages, but has made her progress solely through the force of scientific knowledge and the education of her people. I am an intense believer in the ability and stability of the Briton, but he cannot successfully face the competition of the world with the obsolete weapons now at his command." (1)

Mr. J. Whitburn, says: "I am convinced that however great the achievements of the past have been, they are as nothing compared with the progress which I believe will be made in the immediate future. On every hand I saw the evidence of a scientific and technical training in industrial operations. I believe that American employers by the adoption of the wise policy of giving encouragement to men of inventive minds, by rewarding those who suggest improvements in machinery, have done, and are doing much to increase their trade and to menace that of British producers who are in any way brought into competition with them. So far as I can see, there is urgent need for all those who are in any way concerned about the future of our industries to give the most earnest consideration to the question of the practical education of our artisan class, for, after all, the man of science cannot be effective in industrial operations unless there are those about him who can effectively carry out his ideas." (2)

To this evidence might be added the testimony of two men in England, Prof. Henry Louis, professor of mining, Durham College of Science, and Mr. J. S. Martin, H. M. Inspector of Mines, Bristol: the one teaching mining engineering, the other a practical coal-mining man.

Prof. H. Louis, says: "The better the education of the working miner, the greater the safeguard against accidents. Statistics show that the vast majority of them are due to ignorance or gross carelessness. Fully two-thirds of the annual roll of accidents would be preventable by training the miner in thinking power and in the elementary principles of science.

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(1) Mr. A. Mosely: Report of Mosely Commission. Preface, pp. xiii—xiv

(2) Mr. J. Whitburn: Ibid. p. 392.

"The future of our great mainstay, the coal trade of this country (England), lies to a very great extent in the hands of our coal-miners. It is from among them that the subordinate officials of the collieries must be selected, and just as it is true that 'the backbone of the army is the non-commissioned man,' so it is certain that the working qualities of any pit depend to a very great degree upon the character of its deputies.

"The mining engineer of the immediate future will be called upon to control vast undertakings depending for their profits upon a large tonnage of production accurately calculated, and worked within the narrowest possible margin. Under these conditions it will only be thoroughly scientific administration that will be able to keep expenses below income, and all the resources of modern physical science will have to be pressed into service." (1)

Mr. J. S. Martin, H. M. Inspector of Mines, Bristol, was employed thirty-five years in collieries in Westphalia by a company which brought Mr. William Coulson from the north of England to sink their shaft. He says: "The Germans were ready to learn what was being done in Britain. They had applied British practice to their Germany theory and thus while we (the English) were sleeping as the result of self-conceit they had left us far behind. It was the application of practice to theory derived from scientific education that had produced such favorable results in Germany." He (Mr. Martin) "hoped to see Great Britain now awakening to a sense of technical and scientific education, holding its own position in the world by means of the combination, as otherwise we soon should be left far behind in the race we are trying to run." (2)

No less a person than the ex-prime minister of England, Right Hon. A. J. Balfour, expressed the following sentiments in a public address on the occasion of the opening of the new building of the Manchester School of Technology, Oct. 10, 1902:

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(1) Technical Education in Mining. Henry Louis, M. A., A. R. S. M., etc. Trans. Inst. M. E., Feb. 22, 1898, xv, 8.

(2) J. S. Martin, H. M. Insp., Bristol: Discussion on A. R. S. Redmayne, The Mining Dept. of Univ. of Birmingham.—Trans. Inst. M. E., 1905, xxviii, 479.

"In 1850 Great Britain produced more pig-iron than all the other countries together, but in 1900 the United States had left her far behind, while Germany had almost reached her. In 1901 the United States had increased their production by some million tons, while England and Germany had gone slightly back. The United States have supplied rails for India, bridges for Egypt, iron, etc., for South Africa. And this competition between Great Britain and the United States has not been confined to the supply of iron and steel, but also to all classes of machinery. I heard in England of purchases—especially of rolling-mill machinery made in Germany—by members of the highly esteemed Iron and Steel Institute on the occasion of a meeting which this institution held at the Duseldorf exhibition. The German factories were able to supply the machinery in shorter time than the English. American machines have forced their way into Prussia, Scandinavia and other countries where England had formerly a good market, and large quantities of American-made machine-tools are imported to England, South Africa and other of its colonies. Further, 300 railway coaches have been supplied from Jersey City to the land of the Pharaohs, and the electric tramway from Cairo to the pyramids is run with cars from Pittsburgh.

"The reason that American bridges can be preferred, in Egypt for example, to English bridges, is to befound not only in the shorter time of delivery, but in the lower price. Now, Englishmen may possibly have said to themselves: 'If it amuses the Americans to supply steel bridges at a price of $60 a ton, where our charge would be $75, at which price we have plenty of work, there is no reason to deprive them of such amusement.' But the question is, firstly, this: How long can British firms continue to obtain work at the higher price when the fact has become generally known that bridges can be more quickly and cheaply bought in America? And, secondly, might it not be possible to turn more work out of the English bridge-building workshops—which undoubtedly had a considerable amount of work on hand—if they were equipped with more up-to-date appliances?"

These remarks seem justified by the following figures:—

The world's production of pig-iron in tons:

	1850	1900
Great Britain....	2,300,000	8,960,000
United States	564,000	13,789,000
France	406,000	2,670,000
Germany and Luxembourg	350,000	8,381,000
Other countries	781,000	6,288,000
	4,401,000	40,088,000

The world's steel production in tons:

	1850	1900
Great Britain....	40,000	5,050,000
United States	2,000	10,188,000
France..	15,000	1,569,000
Germany and Luxembourg	10,000	6,258,000
Other countries...	18,000	4,066,000
	85,000	27,131,000

Mr. Balfour goes on to say: "In spite of the immense industry which England still possesses, its supremacy has been most seriously encroached upon, and this state of affairs may become still more serious when, with time, English coal-fields become worked out.

"Twenty years ago it was realized that the want of technical education was hampering English industry, and the development in this direction was so rapid that while the number of technical schools in 1882 was 1402, and that of their students 68,581, the same figures had increased in 1895 to 2673, and 190,386 respectively.

"Lately, however, it has been clearly understood that the principal cause of the whole difficulty is lack of organization of advanced technical education, or, as it might be termed scientific technical education, and the fact that many students taking up the higher course have not the necessary elementary knowledge. Again, manufacturers appear to so little appreciate the advantages of employing scientific, technically educated men, that little encouragement is given to such men to follow such a course of training"

These were the main points towards which the address of Mr. Balfour was directed.

Prof. H. I. Hannover of Denmark investigated the leading colleges and also a large number of factories in England, and gives the following information :—

"During my visits to many of the best known industrial works in England, I was struck by the absence of leading men who had received a scientific training. Most of the positions were held by practical men, who were undoubtedly clever men who had risen through their ability ; but having no other technical education than that derived from the workshops and technical evening classes, they were only fitted to run on the old track, and not to strike out on new lines. I think it no exaggeration to speak of the damned 'practical' men in England, for the exclusive use of him is indeed the reason for the industrial stagnation.

"It is the great passion for the practical man, who was so wonderfully practical, and the considerable contempt for the scientifically educated man, who was so wonderfully impractical, that has, until now, kept the latter away from English factories. A similar state of affairs existed some years ago in one of our Danish machine works, and gradually caused its decay, until scientific technics, allied with mechanical ability, got access to this our largest industrial establishment, and put it right again." (1)

What lesson is there in these criticisms and warnings to England? Just this—that they could all be levelled at this province by the substitution of the words Nova Scotia for England. And yet a greater lesson. England has waked up and is striving to remedy her defects. We have not.

What further should all this mean to Nova Scotia? The lesson is obvious. This province should follow the illustrious examples set her and establish an adequate system of technical training, of its own, to meet its own needs. I say an adequate system. I do not think that we need any $1,000,000 or $2,000,000 central institution or a university to rival the best of those of the United States and Germany, which are the products of years of growth and millions of money. We must soberly reflect that there are only 500,000 souls in Nova Scotia against the 80,000,000 of the United States or the 43,000,000 of Germany. Our institution should be commensurate with our present needs, to be developed as the needs develop. I do not think that we should have, or try to have, the best equipped laboratories in America, for I think many universities have overdone the matter of lavish equipment, to the point of bewildering the student, instead of making him thoroughly acquainted with fundamentals and types. I do believe strongly, however, that a strong central institution of engineering should be established at some point in the province, where there should be taught the branches of civil, mining, mechanical, electrical and perhaps chemical engineering, and the pure sciences of mathematics, physics, and chemistry, to the degree required by the engineering courses. Forestry and fishing should receive early attention also, and scientific judiciousness substituted for the present wanton destruction of these two great assets.

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(1) English Industry and Advanced Technical Education. Prof. H. I. Hannover, director of government testing laboratory, Copenhagen, Denmark. Engineeering, Oct. 16, 1903, 542—545.

This institution should be openly for the benefit and use of the province, and should stand ready to assist any manufacturing venture, to aid in developing any new industry. The laboratories should be available for the solution of problems arising in all the industries of the province. The institution should receive remuneration enough for such research on special investigations, to partly defray the cost, even as it is in Germany. Beside this the professors of the institution or a special corps of instructors should open classes in all the large industrial centres, there to supply teaching of such order as the workman desirous of an education but tied to earning his daily bread, can assimilate.

It is needless to say here, that with this higher institution established, there will have to be provision made in the secondary schools, for the necessary preparation for this higher technical training.

I say that all these things should be done by a central institution. You ask, By whose agency? I maintain that there is but one single force in the province strong enough to cope with the question of technical education in its entirety from top to bottom, and this force is the government.

I know that there are many objections to this scheme. People say, If we establish a college and turn out a number of graduates every year, you cannot find enough places of employment for them. To such I say that they are depending on a set of conditions in the future which are just the same as those existing today. They are preaching a doctrine of stagnation. The institution and its graduates should induce new and large industries and these react on the institutution to the mutual benefit of both. This country should grow, as Germany has grown, more and more prosperous each year, and the demand for trained workers should grow proportionally.

Other objectors say, There are so many different kinds of industries that it is impossible to give instruction to them all.

To them I would say that the bases of all industries resolve themselves into a few branches of technical education. If the student masters one of these branches, he can go forth into the world and adapt himself to almost innumerable modifications of this branch.

Others still say, We will train these young men and then they will go away. Perhaps they will. You can rest assured that if they have to go to other places for their training, they will not come back here. If you do not educate them here and try to stimulate and enlarge industries by scientific training and research, they and the others that would be employed with them will leave for more lucrative fields. No doubt this will for some time be a drawback, but will this movement not tend on the whole to stop the disastrous emigration at present, whereas many people leave each year as are born in that time? Surely if we must send Nova Scotians abroad, it were better to send trained ones.

We must wake up. This is an industrial age. Everything reeks of industry. The greatest country is that which has furthest invaded the sphere of industrial business and science. We must not walk along forever looking backward, dreaming of the grand days when Aristotle, Plato and Socrates, were the leading spirits of the world ; we must see what is in front of us, must acknowledge the great captains of industry. The individual may choose his own proportions of business activity and mental culture, of science and classics, and blessed be the man who happily blends the two. The trend of the age is, however, toward industrial development in every direction, and a state or country or province cannot afford to refuse to recognize this. Its citizens must earn bread and butter, and in these days the means of earning bread and butter are mostly dependent on one or the other of the great industries which are controlled by technical methods and laws. The pendulum may swing back in a hundred years from now, and the technical training to the inadequate one, but that concerns others. We are living to-day and must face existing conditions.

Shall Nova Scotia stand at the window and watch the rest of the world move by, or shall it go out and join the procession of progress? Nova Scotia stock is as good as any in the world. Shall we not give our young men a fair chance? This province is blessed with many resources; shall we not develop them to their fullest extent?

DISCUSSION.

W. C. MILNER.—We are much indebted to Prof. Sexton for his thoughtful and interesting article. Such articles as that must profoundly affect every young man in the country. For any man who is looking for an occupation, Nova Scotia is a country of magnificent resources. No part of Canada has greater resources, except, perhaps, British Columbia. We have splendid harbours, forests, mines, minerals, fisheries,—everything to make a great country, and still Nova Scotia is a backward country. We are at a standstill according to the last census; no less than thirteen counties of the province lost population. If it were not for the population we gained in the counties of Cape Breton and Cumberland the total result in Nova Scotia would be a loss in population. We went behindhand in our agricultural districts during the past ten years. We lost population in every agriculatural district. The total result of our agricultural products was a loss. Why is all this? Why is it that Nova Scotia is backward? Why is it that we are behind other parts of the world? It is because our people are working with their hands instead of their heads. According to statistics, ten per cent. of our population belong to the professional classes. Our schools and seminaries of learning are all devoted to educating that ten per cent., composed of teachers, lawyers, doctors and theologians. The workingman is not taught at all. Ninety per cent. of our people are not properly instructed. We send our boys out without giving them any training of their hands and eyes. Our workmen are sent out absolutely without any skill in the various avocations in which they are to be employed, such as they are obtaining in the United States and Germany, and to some extent in England and France. It is only a few years since Nova Scotia had to employ a horticulturist. Where did we get him? Did we get him from any of our schools or colleges? No, we had to bring him from the United States. We all remember when the Dominion Iron and Steel Company was constructing its plant in Sydney. Where did it get its skilled men? They were all brought from abroad. Why is it our schools and colleges are not giving us men to fill these positions in the land? It is because they are entirely deficient; they are not doing the necessary work for the country. Now the time has come when there must be an awakening. We should have a chance to give our boys a training so that they can develop the dormant resources of our country. The way to do it is to call upon the government to take hold of this matter and deal with it in a large manner. There is a general complaint that we have too much politics in this country. Let us have less politics and more education. Let us endeavor to urge upon the government the development of a scheme that will give this country a good, solid, advanced system of technical education.

In order to bring this matter to a focus, I move that a committee be appointed to call upon the government on behalf of this society, to ask it to take up this question of technical education; and that Mr. Hayward, the president of this society, Prof. Sexton, Dr. Woodman, Hon. Mr. Drummond and Mr. Pearson be members of that committee.

R. H. BROWN.—I have great pleasure in seconding that resolution.

PRESIDENT HAYWARD.—I am extremely impressed with the paper of Prof. Sexton. It impresses me more and more with the subject of technical education. It seems to me to be the stepping-stone to progress. Nature has provided us with resources, and it is our duty to develop them.

The motion passed unanimously.

The Relation between Technical Education and Industrial Progress.

By Professor R. H. Richards,
Head of Mining Department, Massachusettes
Institute of Technology.

(An address delivered 22nd March, 1906.)

I have been asked to address you upon the close relation between technical education and industrial progress. All clear thinkers agree that there is a close connection between the two, but that to be effective the education must be of the right kind.

Industrial progress in the last fifty years has consisted in seeing an opportunity and in finding a way to make the most of it.

About 1870 in the United States the opening up of new territory called for iron, for railroads and agricultural tools. The best iron blast-furnaces of the United States were then making 25 tons of pig-iron per day. They were in the hands of iron masters who learned their trade at the furnaces and did their work as they had been taught by their predecessors. Any suggestion of change from the adopted method drew out the reply "That was tried in my grandfather's time and proved to be a failure." The furnace method had been at a standstill for years and improvements were apparently impossible. At about this time the American scientific schools began turning out their graduates, and the Americans who had obtained similar training abroad returned. These men brought in a new leaven, and the resulting increase in the work of a furnace is represented by the following figures :—

Charcoal Iron Furnace.

Date	Hearth	Height	Capacity
1870	2 ft. 6 in.	39 ft. high	10 tons per 24 hrs
1890	6 ft. 7 in.	60 ft. "	130 " "
1904	8 ft. 6 in.	70 ft. "	160 " "

Anthracite Iron Furnace.

1870	10 ft. 6 in.	40 ft. high	25 " "
1890	11 ft. 4 in.	73 ft. 11 in	100 " "
1905	14 ft	100 ft. high	465 " "

Coke Iron Furnace.

1897	10 ft. 5 in.	75 ft. high	207 " "
1904	12 ft. 6 in.	85 ft. "	321 " "
1904	15 ft. 4 in.	100 ft. "	500 " "

Lead Blast Furnace.

1870	2 ft. square	12 ft. high	12 " "
1880	26 in. x 100 in.	14 ft. "	60 " "
1890	42 in. x 140 in.		120 " "
1900	48 in. x 164 in		160 " "

Copper Reverberatory Furnace.

1878	15 ft. 0 in. x 9 ft. 8 in.		12 " "
1887	21 ft. 2 in. x 12 ft. 8 in.		24 " "
1894	35 ft. x 16 ft.		50 " "
1904	50 ft. x 32 ft.		90 " "
1906	112 ft. x 19 ft.		340 " "

Copper Blast Furnace.

1881	28 x 28	8 ft. high	35 " "
1883	48 in. diam.	10 ft. "	60 " "
1885	48 x 121	8 ft. "	100 " "
1900	56 x 180	18 ft. "	400 " "
1904	56 x 19	18 ft. "	500 " "
1906	46 x 612	18 ft. "	2600 " "

The same wonderful progress is true of the Bessemer process. When it was first introduced into the United States about 1868 two converters could work five charges of five

ons each, 27 tons in all per day. Now, through the improve-
ents brought in by the introduction of scientific methods, two
onverters can make 900 to 1000 tons of steel per day. Names
rominent in this advance are Holly, Wood, Schwab, and others.

The story of the copper furnaces has been the same. The
everberatory of 1878 had a hearth 9 x 15 and worked 12 tons
er 24 hours. The Argo, Colorado, reverberatory now has a
earth 19 x 112 and works 350 tons.

The lead furnaces of 1870 were 24 in. square in sections and
melted 12 tons per 24 hours. Now they have sections 48 x 164
nches and smelt 1600 tons per day.

Such extraordinary development as this did not come with-
ut resistance from conservatism, it came as the direct effect of
he application of science and the scientifically trained mind to
he subject in question. It is true self-made men have been
resent in this wonderful procession, have done their share in
ringing on the advance, and have done it nobly, but they
alked side by side with the technically educated men and had
heir trained chemists. They read and studied the current
terature.

Having noted a few main facts of the development along a
ew lines, let us look a moment at some of the impediments
hich had to be overcome.

We first come to the classical college as it then was. The
peaker's own experience may be cited:—He had been at a
lassical preparatory school until two years older than the nor-
nal age. He worked industriously and seriously but made little
rogress. The work was always up hill and required great
ffort to keep his attention. At the last moment a change was
ade. Instead of going to a classical college, he went to a
cientific school, where he was immediately fascinated by the
tudy of scientific phenomena, of chemistry, physics, geology,
ngineering. Instead of having to drag himself to his books, he

could not keep away from them: instead of reading books o ancient history and mythology to please his teacher, he now trie experiments to demonstrate laws of nature for himself, and rea the authors at first to see if his demonstrations accorded wit theirs, but afterwards to see if they agreed with him.

The right to question even what is written in the books, i not only the right but the duty of every scientific man.

The speaker's experience has been that men who have bee brought up on the classics have their best field in literature, law theology and politics, where oratory and logic of persuasio count most, and that those who go from this training into mining, metallurgy and manufacturing, have a certain bondage t authority to overcome, but when men of this class are emancipated from the bondage to authority they furnish the fines examples of intellectual ability.

The men who have been graduated from a scientific school have been taught to observe, record, collate, conclude—to observ the phenomena as they are occurring, to record what they see as it really is, without a bias, to collate the results, correctin instrumental and personal errors and tabulating results so as t conclude wisely what is to be expected from the premises. Me who have been taught by this method have learned how difficul it is to see and how important it is to keep an open mind i order that wisdom may have a chance to act. The moder scientific man is most courageous in experimenting, his imagination has been highly cultivated, nothing daunts him, he annihilates time and space and does in a year the work of a forme generation. He knows, while he may be disappointed again an again, that if he can only find the true cause and sequence o facts, he can then press the button and the results will follow.

“ Why not let opportunity make the man ?” is asked. Dr Drown has answered “ A technical school is a device to sav time. Man's days are still three score years and ten, but no e crowds as much into them as Methuselah did into his nine undred and sixty and nine years"

Mr. Chamberlain of England says, "I do not think it is ecessary for me to say anything as to the urgency and necessity f scientific training. It is not too much to say that the xistence of this country, (England) as the great commercial ation, depends upon it"

While the classically educated men have been the main stay f society for a long time, on the lines where they are strong, hey did not bring about the modern industrial progress or help n it until the modern engineering schools led the way. Since hat time the colleges have come into line, each with its engineering and chemical departments.

The eye and the mind.—The importance of hand work in he school for demonstrating the fact that when we look at a hing we do not see it all, has been proved beyond all doubt. n the speaker's own experience he constantly hears from some tudent, "I have tried that machine for concentrating this pro-uct and it is a failure." The teacher's reply is, are you sure ou tried the experiment rightly and saw everything that was oing on? A repetition of the test frequently brings a reversal f the decision. The speaker has known many cases where mprovements have been turned down simply because the eye nd the mind of the experimenter have not been sufficiently rained to grasp the bearings of what was being done.

The effect of the practical school training upon an engineer s well shown in this instance. The engineer referred to sent a rawing of an intricate forging to a firm in one of the southern tates. The manager sent it back, saying the piece could not be ade. The engineer, thinking the former had misunderstood he drawing, made a wooden model of the exact shape he wished he finished piece to have. This he carried over to the works in erson. The manager said, "Not only are we unable to make this piece, but the man does not live who can make it." The engineer said, "May I have the use of a forge?" This was granted, and the expert blacksmiths of the place collected around him to see this greenhorn of an amateur make a fool of himself. He worked through his task logically, step by step, and brought out the finished piece, just like the wooden model. He was then asked by the manager, "Did you ever see one made?" "No." "Did you ever see one made like it?" "No." "How did you know one could be made and where were you taught to make it?" "I was taught the principles on which everything is made at the Massachusetts Institute of Technology of Boston." At this reply the manager said, "I don't believe a word of it."

The above is a very good illustration of the different way in which the two classes of minds look at things, the trained scientific mind is ready to undertake anything. The rule-of-thumb man will go as far as he sees, but then his imagination fails him. The former can mentally analyze and reconstruct, while the latter can do only what he has been taught.

The use of the shop for the development of skill and imagination in the school is well illustrated in this way: the teacher of forging in successive lessons show how to draw a piece of iron, how to make a piece round or square, how to punch an eye, how to make a weld, how to make an offset and a rivet. He then asks his pupil to make a pair of blacksmith's tongs. The answer comes "but I can't, I never did such a thing in my life." The teacher is inexorable, and the pupil begins. He finds to his surprise that the task before him is simply a grouping together a series of steps all of which he has already mastered. The first tongs a good student makes will rank well with the work of an average country blacksmith who has had years of experience.

The change from the rule-of-thumb man to the scientifically trained man has not been without its difficulties, most of which had their origin in the jealousy of the former and the inexperience of the latter.

It is interesting to note the devices to which the young scientist has to resort in order to overcome the barrier of conservatism. Seeing great waste of good material taking place for example, at an iron blast furnace, he at first asked permission of the iron master to save it by putting it in the furnace. He was met by the stock remark, "My grandfather tried that and proved it a failure.' The young man then tries the opposite tack. Analysis of the usual ore and also of the said waste material were placed side by side on the manager's desk. This was done repeatedly as an apparent coincidence, until the manager noticed one day that the alleged waste material was richer than the ore and he said, "I believe that stuff would make iron after all," and ordered that the trial be made. As soon as it is became the act of the manager and he received the credit for it, the saving was all right and the thing to do. When the young scientist found his diplomacy had triumphed in the first case he tried again on another line. In this way time and again, advances were made, until the real soucre of improvement was recognized by the capitalists and the young scientist had gained sufficient experience to make it safe, then the old conservative manager gave place to the younger progressive one.

An exceedingly interesting case of the breaking down of conservatism shielded behind barriers of religion and nationality, as well as international distrust, occurred to a young American who taught a school in India. He recognized early that the teaching of tool work must be more forceful for his purpose than book work, but he saw also that to introduce foreign tools would excite antagonism at once. He therefore set the Hindoo young man to work designing a tool to cut wood. A little careful unnoticed guiding on the part of the teacher brought the young designer to the modern approved form, but the tool was the Hindoo's own design; he had not only made it but he had created the idea; the credit was his. The barrier thus broken soon fell, and progress was rapid.

Many instances could be given where industrial progress has lagged because advantage of technical knowledge was not taken. For example: In geological work the speaker once knew a young school man who at a mining summer school was taken by a local home-taught mineralogist and geologist at the eastern slopes of the rocky mountains in Colorado, to visit certain outcrops around the vertical coal seam there being worked. The young graduate quickly reconstructed from the fragments, the probable geological structure of the place, including a syncline with axis north and south and the .coal mine on the western slope, combined with a horizontal bedding extending indefinitely eastward. From these scattered fragments he predicted that a coal seam would be found 200 feet deep, more or less, in the eastern plane, in undisturbed and therefore better condition than in the coal mine then being worked. He reported his conclusion to the manager and to other prominent men. They all turned it down as a dream of a school boy or the notion of a "scientific cuss."

Twenty-five years later it was found that many square miles of coal did underlie those plains. In this instance not only the business and coal manager could not see it, but the home taught geologist had not thought of it until his attention was called to it.

In another instance a young man went to Maryland to survey coal property in a syncline valley. He noticed that where the central river bottom and the branches cut below the coal, the following of outcrop was easy and the survey simple but the outside croppings were blind. To run these in his survey he designed a geometrical rule by which he ran long distances of outcrop, coming out at the next visible sign near enough to plot the ines. The young country surveyor who helped him was greatly aken with this plan and laid it up in his mind.

Twenty-five years later the latter met the former and said, "Some New York parties came down here and wanted to buy oal land outside our lines. I told them there was no coal there nd that they would be disappointed. They persisted, made heir purchase, put down borings, but found no coal." Here the usiness man refused the advice of the scientist and suffered in onsequence.

Pure logic forms a bulwark behind which conservatism an rest, in this way pure logic builds upon known facts a structure of argument that if certain things are known certain ther things will follow. The comment comes from Edison, Whitney and others in words to this effect, "in questions of ndustrial progress no man living knows all the facts and so he questions of success or failure cannot be answered by logic until not not only every probable and possible thing has been tried."

As previously pointed out, technical education is acquired not alone in the school but in contact with fellow workers. In the United States the interchange of visits and cordial comparing of notes has been the rule. Some change in the way of shutting out visitors is now coming in, which is to be regretted. An instructive example along this line came in a Pittsburg meeting of the American Institute of Mining Engineers. On one of the excursions two old friends were conversing and one said, "I always thought my works were the most advanced of any, in consequence, I have never asked others to visit me and so have not visited them. I now find that I am at the tail end of the procession."

Not only are men blind and conservative but nations are still slower to adopt new ideas. Sir Norman Lockyer says:— "Britain in the middle of the last century was certainly the

country which gained most by the advent of science, for s
was then in full possession of those material gifts of natu
coal and iron, the combined winning and utilization of whi
in the production of machinery ano, in other ways, soon ma
her the richest country in the world, the seat and throne
invention and manufacture, as Mr. Carnegie has called her."

The beginning of the decline of British supremacy in man
factures has been said to date from the time when A.
Hofman left England to go to Germany because a few thousa
pounds needed to pay him and equip his laboratories were
forthcoming. The government officers who should have appre
ated the situation and his value to the kingdom, did not, and
the result his wonderful inspiration and storehouse of experien
was taken from England and given to Germany.

Sir Norman Lockyer in his presidential address before t
British Association in 1903, said :—"Our position as a nati
our success as merchants, are in peril—chiefly—dealing wi
preventable causes—because of our lack of completely efficie
universities, and our neglect of research. We now know fro
what has occurred in our states, that if our ministers had be
more wise and our universities more numerous and efficient, o
mental resources would have been developed by improvemen
in educational method, by the introduction of science in t
schools, and, more important than all the rest, by the teac
ing of science by experiment, observation and research, and n
from books. It is because this was not done that we ha
fallen behind other nations in properly applying science
industry, so that our applications of science to industry a
relatively less important than they were. But this is by
means all ; we have lacked the strengthening of the nation
life produced by fostering the scientific spirit among all class
and along all lines of the nation's activity ; many of the respo
sible authorities know little and care less about science ;
have not learned that it is the duty of a state to organize

es as carefully for peace as for war; that universities and
r teaching centres are as important as battleships or big
alions; are, in fact, essential parts of a modern state's
hinery, and as such to be equally aided and as efficiently
nized to secure its future well being.

Suppose we were to set about putting our educational house
rder, so as to secure a higher quality and greater quantity
rain-power, it would not be the first time in history that
has been done. Both Prussia after Jena and France after
n acted on the view:

"When land is gone and money spent,
Then learning is most excellent."

After Jena, which left Prussia a "bleeding and lacerated
s," the king and his wise counsellors, among them men who
gained knowledge from Kant, determined, as they put it,
supply the loss of territory by intellectual effort."

After Sedan, a battle, as Moltke told us, "won by the school
er," France made even more strenuous efforts. The old
ersity of France, with its "academies" in various places,
replaced by fifteen independent universities, in all of which
faculties of letters, science, law and medicine.

But even more wonderful than these examples is the
ellectual effort" made by Japan, not after a war, but to pre-
for one.

The question is—Shall England wait for a disaster, and then
ate Prussia and France, or shall we follow Japan and thor-
ly prepare by "intellectual effort" for the industrial
ggle which lies before us?

The effect of Technical Education in the United States.

n the United States the most interesting aspect of industrial
ress is the atmosphere of alertness that prevails, in contrast
he conservatism in the old country. Is is so contagious

that it affects all who come. This is well illustrated in the cas of a Welsh copper metallurgist who came at an early date t the Rocky mountains and soon absorbed progressive idea Just after he had rebuilt his copper furnace so that its capacit should be increased from 40 tons to 80 tons, he received letter from a friend in the old country saying, " We are contemplating increasing the capacity of our furnace from five ton to six tons. Do you think it would be safe to make the change The former replied, "After careful consideration of your questio for a week, I think it would be safe."

How comes it that there is this alertness and adaptability It is partly in the air. The speaker believes the modern schoo of the class of the Massachusetts Institute of Technology hav had a large share in this. They take the boy from the hig school and before he has lost his youthful enthusiasm and hi quickness in learning, equip him with the principles, blaze ou his path for him, and turn him out well started along the roa to become an engineer. The fact that he begins his practica work in the world of practice before he has passed the age o greatest acquisitiveness, is a very strong point in favor of course involving only 4 years from the high school.

Sir Norman Lockyer states that " In the United States th most successful students in the higher teaching centres ar snapped up the moment they have finished their course of training and put in charge of large concerns."

(The speaker differs from the last part of this quotation He hopes that none of his pupils will be rushed ahead at quit that speed.)

In Great Britain, on the other hand, apprentices who can pay high premiums are too often preferred to those who are wel educated, and the old rule-of-thumb processes are preferred t new development.

It has been repeatedly noted that in England the training f skilled workmen and foremen is carried to a high degree of xcellence and the training of engineers and leaders has been eglected, but the exact opposite is the case in the United tates.

At this stage in industrial development, everybody believes n education of the right kind as a help, and the question which naturally asked is,—What is the right kind? The speaker inks that kind is right which is represented by the Massa- husetts Institute of Technology.

The United States technology schools, engineering depart- ents of universities and the state mining schools, all give urses in the various lines of engineering and chemistry. apital for this training has been furnished liberally by indiv- uals, and high tuition has been paid by students who see the mediate profit coming from the investment. The great pro- ress in the United States dates from their beginnings.

The Technische Hochschule of Charlottenburg (Technological chool of Germany) fits men for the various engineering pro- ssions and for chemistry. A recent catalogue showed 3000 udents, the length of the course about four years, the number f graduates 80. This is about 10% of the class if the class as about 800 in it.

The students of the Technische Hochschule are allowed to a mited extent to participate in the tests of the testing station n the capacity of assistants. But as Lichterfelde is one of the burbs of Berlin and Charlottenburg another, they are not ited for close association with each other. The other German ates also have Technische Hochschules.

In regard to the English schools, according to quotations om Lockyer, the technological schools have not reached the andard of those of Germany or the United States. The speaker has not been able to corroborate or refute this statement on account of the brief time allowed to prepare this address.

Modern education is no longer a log with Mark Hopkins at one end and a boy at the other. It is no longer Greek roots and Latin tenses. The education we have referred to deals with the principles of chemistry, physics, electricity, mechanics, metallurgy and ore dressing, as underlying industrial progress.

To elucidate the principle, laboratories are needed, supplied with the requisite apparatus.

The laboratories of ore dressing, with which the speaker is connected, are supplied with small machines with which to test the concentration of ores. The small size diminishes the first cost, running cost and exhaustion of students from handling heavy weights, and yet the apparatus is large enough to decide all the important questions of designing a mill process. They can tell when crushing to 16, 8, 4, 2, or 1 mm. in size whether the slimes saved by the coarse crushing more than offset the better and cleaner concentration with fine crushing, and many other important points.

The question is asked,—Should professors do expert work? The speaker thinks that by all means, yes. Their teaching is greatly strengthened by having a little connection with the world of action, it helps to keep them awake and up to time in the problems of the day. They should not, however, allow it to rob the students of the time they have a right to, and the outside practitioners will be very nervous if the school men, with the added prestige coming from their position in the school, appear in serious competition and take away much of the business.

Should research laboratories be established? The arguments are strongly in favor of them. In the United States laboratories connected with the schools are being installed and are helped by he Carnegie Foundation.

The large corporations are realizing the importance of research laboratories. The General Electric Company and Westinghouse Company both have laboratories covering acres of floor space. The former has 20 to 30 assistants constantly on new work, so great is the field for industrial improvement and the consequent profit to the company.

At Berlin, Germany, the Government Testing Works (Versuchsanstalt) at Lichterfielde West, have the following departments:

Metal testing, for tension, compression, torsion, elasticity, conductivity, heat treatment, corosion, &c.

Building materials for brick, mortar, cement, concrete, and other materials for strength and durability, density and absorption.

Paper for strength, absorption, filtering power, by microscope and other means.

Metallography, testing of metals by etching, polishing, microphotography, the eutectic curves of metals and other tests.

The laboratory is also provided with a variety of heating, annealing and melting furnaces.

General chemical testing — complete chemical laboratory for chemical analysis of metals, of materials used in manufacturing, of gases, and others.

Oil department—both mineral oils and fats for fludity, flash point, ignition point, refractivity, vacuum distillation, determination of sulphur and others.

Samples are tested without charge or for pay. In the former case results are all published in the annual report for benefit of the public, those that are paid for, on the other hand, are treated as confidential.

There is also the Berlin Establishment for standard weights and measures for comparison by manufacturers and users, and also

Berlin Physikalische Reichs-Anstalt, an establishment for research in chemistry and physics.

The other German states have testing stations of the same general character as that of Berlin, Prussia, but they are not developed to quite the same extent.

In the United States the Watertown Arsenal has a department for testing in charge of the ordnance department of the United States Army. There are three kinds of work done at this station.

1. Testing for the ordnance department of metals and materials for guns, &c.

2. If the above work is not pressing, general tests of engineering materials are undertaken. The results of these are published.

3. Work for individuals for a fee. The results of these tests are treated confidentially.

The United States Geological Survey is doing work on the testing of structural materials and fuels. During last summer it undertook also the testing of the black sand, in which the speaker took part. From the seas and river sand, as well as the sand from hydraulicing and dredging for gold, minerals of commercial value were obtained, namely, magnetite, chromite, garnet, monazite, and zircon. In some cases they will prove to be of economic importance.

The Bureau of Forestry of the department of agriculture is making timber tests.

Many of the schools and colleges do some testing of materials of engineering, of ores, and of chemical products for private parties independently of the government.

An instance of the effect of testing and inspection is here given. An army officer, inspecting the pistols of a large manufacturing concern in the United States, during the war of 1862, rejected a large order because of variations in calibre and other slight deviations; he appeared to be doing a harsh act, and one hard for the manufacturers to forgive. He really made the fortune of the manufacturers, because they doubled up on the care expended in the construction of the pistols, produced a first class article for sale, and the business was greatly increased. This is also a good instance of the benefit of government testing works to a country.

In conclusion—How shall the advantages of participation in the general industrial prosperity be gained?

The reply seems to come on all sides, establish research laboratories, testing laboratories, and technological schools or engineering departments in universities.

If a country somewhat behind in the race seeks to catch up and finds donations from public fortunes are not available, it is surely good politics as well as good patriotism to use some of the tax payers' money to start and carry on these good works on a liberal basis.

Technical Education.

Y PROF. EBEN MACKAY, PH. D., Dalhousie College, Halifax.

(An address delivered 22nd March, 1906.)

I have been especially glad to hear Professor Richards's views n technical education, because they are the views of an eminnt engineer, and not only so but the views of an engineer who as had exceptional opportunities of forming sound ideas on his subject, and the views of an engineer who has been onnected with the work of an institution which I think has no uperior on this continent or in Europe as a training school for he captains of industry. The more one comes to know of the assachusetts Institute of Technology, the more one comes to now of the high standards it sets for its students and of the igh ideals it places before itself, and the more one understands hat a mighty service that institution has done for the indusries of New England, and not only for the industries of New ngland but those of every country her graduates have gone to. have only one fault with the Massachusetts Institute of echnology, and that is that it is in New England and not in ova Scotia. I am afraid there is no chance of our getting it ere, but our attitude on that question should be like the attitude f a young man in the west of which the papers have told the ollowing story. He fell in love with a charming young lady, hom he thought had all the qualities that he was in search of. e carried out the preliminaries and came to the question which am told is usually asked under those circumstances, and he was irmly and kindly "turned down." Now the young man in uestion might have done many foolish things, but I think he did very wise thing—having seen a model that he liked, when he ould not get the original, he tried the next best thing and made ove to her sister, and there was successful. (Laughter). Now, I

think we in Nova Scotia may take a leaf out of the book
this surprising young man. If we can not have the Institut
Technology here, we can at all event try to get something l
it. We like the model. Can we not build up an institut
in this country which will do for Nova Scotia what the Massa
usetts Institute of Technology has been doing for 40 years
New England ?

While listening to Professor Richards, one remark of
recalled to me a note I read only a week ago in an Engl
newspaper, They have been observing within the last two wee
in England the jubilee of the discovery of the first of t
aniline dyes. We hardly realize now that the first aniline d
was discovered by an English Chemist, Dr. Perkins, in Engla
Professor Hoffman, whom Professor Richards has mentione
predicted here that the time would undoubtedly come wh
England would be manufacturing indigo from coal tar a
sending it to India, and when the tar distilled dyes of ma
colours would be sent to all parts of the world. Profess
Hoffman's prediction has come partly true. It is true th
indigo is now manufactured from coal tar and sent to Ind
It is true that tar-derived dyes of innumerable colours are n
manufactured and sent to every part of the world; but t
country in which that is done is not England, but Germa
England had the coal tar and had the wealth; she had t
discovery; she had everything but the technical education a
the appreciation of technical education which must go wi
it. (Applause). And so it has come about that indigo inste
of being grown on the plantations of India, is now manufactur
on the banks of the Rhine, and that the madder dyes, instead
being produced in the fields of France, are now "made
Germany." Germany well deserves the remarkable succe
which her neighbour's unwisdom and her own sagacity h
brought about. What that success has been we may reali
from the statement that there is invested in that country

e artificial dye industry alone not less than twenty-five or irty millions of dollars—and on that investment from 20 to per cent. is paid annually. How is that for a dividend ? et that dividend is simply the result of technical education,— nply the application of scientific research and scientific train- g to an industry that has been built up as a strictly scientific dustry. Some firms in Germany employ as many as one ndred chemists, and not merely ill-trained chemists, but emists thoroughly trained in the Universities. It was pretty good investment for Germany when she established chnical schools. It may be objected that the coal-tar dye dustry owes its existence to technical men because it is sentially a scientific industry, but that our industries are in a fferent position. I need only remind you that every industry is w coming to be a scientific one and that the days of crude ethods are passing away—they have largely passed away— nd we are now living in the strenuous time when competitio very keen, and if we in Nova Scotia are to enter into the dustrial field as successful competitors, then we must serve the conditions of the game. We must prepare for the ntest. I feel that I should not trespass much upon your ne, and so I shall confine myself to two aspects of the question. would like to point out, first, what we now have in the way provision for technical training, and, secondly what we would ke to have.

I think it would be unjust to give the impression that we ve done nothing in the matter of technical education. the first place the government has established a school of griculture which I believe is doing excellent work, and which under the care of one of our brightest Nova Scotians, thoroughly ained, energetic, enthusiastic, with excellent executive ability. think the people of this Province owe a debt of gratitude the government for this technical school. It is a move the right direction and the country will be greatly profited by its establishment. Moreover, the government has establishe mining schools—they are very elementary—but they hav served a very good purpose and have met a pressing nee There is, however, a wide gap between these mining schoo and the lower grade of the technical classes in Universitie This gap is being to some extent filled by the efforts of priva institutions—the University of Kings College and Dalhous University. Some three years ago Dalhousie College bega establishing classes in Sydney, and Kings College has als established classes in Glace Bay of a similar kind. Classes this kind are now established in connection with Dalhous College in Sydney Mines, Sydney, Stellarton, and Springhil The technical classes of the schools begin where the governme mining schools end, and they are endeavoring to bridge ov the gap in our present technical system.

In the next place, in higher work, in engineering work, th Universities of Kings College, St. Francis Xavier and Dalhous have taken up the matter. I can only speak with complet knowledge of what has been done in Dalhousie College, and shall only mention one or two facts. Dalhousie College ha restricted its attention to two departments in engineering. Th Governors of that institution believed they would be best serving the interests of technical education by devoting the resourc they had to building up a small number of departmen instead of spreading them over a large number. As an illustration of the demand there is for technical work of college grad I wish to mention one fact with respect to the Mining an Civil Engineering departments in Dalhousie College. I think th is the fourth year of the mining department—the Civil Enginee ing department is now in its second year—and there are alread in these departments nearly 50 undergraduates in engineerin

Having given this survey of what we now have in the wa of technical institutions, let me spend a few moments in pointin out what my idea is of what we ought to have. First of all

all speak of what is most important—schools for the training
captains of industry, engineering schools. I think that this is
ost important because it is of fundamental importance that
r industrial forces should be effectively led. We have in the
ganization of our industrial forces something that is quite
alagous to the organization of our armies. We have our
rious grades just as in the army—there are the generals,
lonels, captains, lieutenants as well in the industrial
in the military army. There are then captains of industry
hose work it is to direct the policy and make discoveries and
nerally to conduct the strategy of the industrial struggle.
e have some idea of what would happen to an army when war
roke out if the military sagacity of its leaders was found
cking. For exactly similar reasons, we may well be concerned
r the industrial future of that country whose captains of
dustry are lacking in technical education. I do not think it
ill fare any better in modern industrial competition than our
my would fare if badly officered, in the strenuous life of war.
o, first of all, speaking of the training of captains of industry,
think we should build up in this province one technical
stitution which should train young men for every industrial
rofession that is necessary for the development of the resources
f the province. The requirements for industrial development
f the province should be the governing factor in directing the
olicy of such a school. We have our mining industries—our
al mining and our gold mining—we have our steel industries,
nd we have room for many others. So our institution must
ave properly manned and equipped departments of mining and
lectrical and mechanical and civil engineering, in which
ur young men will be able to acquire the training they need
order to play a fitting part in developing these industries.

In the next place, we want not only capable leaders of
dustry, but it is necessary that under those leaders there
hould be capable foremen and capable workmen, so that some

attention has to be paid to the training of workmen—it is a secondary matter but it is important. Just as in an army the training of men to shoot is an important thing, so also it is necessary to have workmen trained for industrial pursuits. The advantage of a trained man over an untrained man is very apparent. Let me illustrate this: An Irishman was invited to a wedding. He went and was shown up to the dressing room, and a few minutes afterwards he came down the stairway in a heap very much disfigured and battered. His host hurried up to him and asked him what the matter was. He said, "I went up to the dressing room and I met a dandy of a chap with a white tie and a bouquet and patent leather boots, and I asked him who he was and he said, 'I am the best man,' and begorra he was." The best man happened to be a trained boxer. (Laughter). We must have our trained leaders of industry and we must have our trained workmen to complete our industrial system. We should have technical schools—the highest grade, the engineering grade of the college and the trade school, the grade for the workmen and lower officials, which can only be taken up to advantage where the workmen are.

The idea is sometimes advanced that the public schools should be converted into technical schools or trade schools—I think that would be a great mistake. I think the public schools have great work to do and should confine themselves to that, and by doing that work well they would be best serving the work of technical education. Let them give their attention to the three R's—after they can give attention to the four R's, not only to reading, writing, and arithmetic, but the mest R of all, reasoning, and I think it will tend to the development and progress of technical education. There is no use putting a trade school where there is no industry. You cannot develop an industry by putting a trade school in a place. The trade school must follow and not precede the industry. But I must hurry on and speak as to the cost of these things. I do not think after all the cost is appalling, as at first sight it appears to be. In the first place there are in this Province various institutions which have a large amount of invested capital in doing work which is absolutely essential to the work of a technical school, and which forms a part of a first class engineering school. We have institutions now for teaching the necessary adjuncts to technical education, representing over one million dollars of invested capital. The amount spent in subsidizing a single mile of railway in this province would be a handsome gift in equipping an undergraduate course in many departments. As to the research departments, we have to build them up as we find they are needed, and find they are best fitted for the needs of the country. We should not be staggered by the expense of building up research departments.

Are we to be the Russians or the Japanese? I think, Sir, if it is put to us in that way we shall not hesitate what reply to give. If we are going to take any fighting part in the industrial struggle, do not let us try to comfort ourselves with the reflection that we can go on in the way we are doing now in the development of our educational institutions. On the other hand, I feel perfectly satisfied that once the situation is clearly understood, no Nova Scotian who understands it will hesitate what to do. Of course there are various ways of going ahead—there are wise and foolish ways, and perhaps all wise men do not agree as to the right way. How the educational resources of this province are to be co-ordinated, and what the educational system is which will properly fit our condition, is a work for a body of expert advisers, who will go into the situation and will gather together the facts, and who will then be able to advise those in authority what they ought to do. Other countries have had technical education for half a century and have been developing their resources to the utmost. Do we think we are clever enough in the industrial game, that we can compete with these countries without any such equipment? I do not think, conceited as we may be, we are equal to it. I look forward to a bright period of history in Nova Scotia. When it is once recognized throughout the country that we need a full system of technical education that our people value, and the wonderful power it gives in the development of the industrial resources of the country, I believe it will not be long in coming.

Technical Education.

By D. Soloan, Principal of the Provincial Normal School, Truro, N. S.

(An address delivered 22nd March, 1907).

I disclaim all pretence of ability to contribute any very definite ideas toward framing a system of higher technical instruction in our province. My knowledge of educational conditions and educational needs being mainly limited to the public schools, it is concerning these alone that I may be permitted to speak with any warrant. Even on this matter I admit that, like many another critic of established systems, I have frequently found it easier to animadvert, to criticize, and to propose remedies, when discussing educational conditions in an irresponsible fashion, than when confronted by higher educational authorities, by councils of public instruction, and by the statesmen whose part it is not merely to discuss academically and in offhand manner, but to hazard new enterprises in education. It is important to recognize certain existing conditions which compel our caution in introducing any radical or very expensive scheme. The days, unfortunately, still linger with us, when among a large proportion of our people, the man with a knowledge of Latin commands admiration, notwithstanding that he may wear patched trousers and may not be able to make a decent living. This tradition we must endeavor to counteract, for it is one of the influences hostile not only to healthy progress in technical education, but also to improvement in the character of the schooling of the people at large. It is this tradition which every school master worth his salt is to-day battling with; not, forsooth, because Latin or any of those purely literary or philosophical studies are evil or worthless, but because it is today felt that secular instruction should deal first of all with matters vital to material welfare, interpreting these important matters in such a way as to promote a culture equal to, although different from, that of a purely literary character. Particular emphasis should be laid upon the consideration here presented, because at the present moment a reactionary movement is being promoted by advocates of the old curriculum who would replace Latin, grammar and composition, in the course of subjects compulsory for every first and second rank teacher in Nova Scotia, in effect fastening these subjects upon the great majority of high school pupils as imperative.

The argument of these well-meaning reactionaries seems mainly to be that Latin, being easy to teach, will therefore be better taught and more effectively taught than are the natural sciences today. Either it never occurs to them or they leave it out of consideration, that a more useful endeavor would be to improve the character of the teaching of the science and the realities of life. The classics must remain and will remain necessities for the young people who look forward to law, medicine or theology—necessities, not chiefly on account of their cultural, but because of their technical value. Education or culture alone is not enough for the people of a new country with undeveloped resources. Character and efficiency today rank higher among us than does mere culture; just as culture certainly ranks above mere ineffective knowledge. This is the spirit of the time. We need have no fear of killing out culture. It will not be destroyed by ploughing under.

Important it is, then, that a system of higher or lower technical instruction cannot thrive unless the modern spirit enter into the body of our common schools and into the community at large. Equally important it is to bear in mind that the welfare of higher technical instruction cannot be promoted by any scheme which would transform our present common or high schools into trade schools. A system of the present must remain. The great proportion of our high school pupils and even of our common school pupils are now destined to practice trades. In the fishing, the agricultural, the commercial community, the boys and girls usually have other employment in view. In the high schools of such communities the boys largely look forward to higher education in some profession or some calling quite different from those which the present important "technical" movement has in view. Then there are the girls, whom we have always with us. They must be provided for, and provided for somewhat differently though not less fully.

A general revolution of the public school on purely "technical" lines must not be thought of. It is not demanded by our people: it is certainly not demanded by our circumstances. But something which does appear as within the horizon of our expanding educational activity is a system of schooling in industrial communities parallel to the general curriculum and specifically responding to the needs of prospective mechanics, operatives, overseers and engineers. No overthrow of existing institutions need be contemplated or even thought of, if, in communities like Halifax, the Sydneys, New Glasgow, Amherst, the public schools above say, the seventh grade, were differentiated into two establishments, the one for general education, the other for technical or commercial training. There would be, it seems probable, a fairly large demand on the part of parents for a more "practical" or "technical" instruction for boys destined for industry, just as there is to-day an increasing demand for instruction in commercial branches, a demand which Halifax has already undertaken to meet. The speaker had in mind his own experience as a teacher in New Glasgow, where the sons of the most intelligent and progressive people were encouraged by their parents to take up the trade of the machinist or of other iron workers. These lads proceeded from the high school to the workshop but, after some practical experience, found themselves poorly equipped in the special mathematics, mathematical drawing, physics and chemistry of their crafts, and, consequently unable to advance rapidly in efficiency. To return to the high school was little benefit to them, for our high schools seldom possess teachers competent to outline or provide the special technical instruction called for.

Now, to this day in Nova Scotia, we appear to be without the facilities for training teachers who should provide the sort of instruction just mentioned. It is not enough to have in mind the addition of this instruction to present curricula. We cannot as yet provide teachers to administer such a scheme. Here, then, we may venture to predict for a higher technical institute a sphere of usefulness not alluded to by either Prof. Richards or Prof. MacKay. The technical institute would provide us with a corps of teachers for these schools. It would encourage industrial communities to take the initiative in organizing elementary technical instruction in their schools. Graduates of three or four years' training would not be required to carry on this elementary work. Men could be trained in short courses perhaps especially designed for that purpose. An encouraging sign is given in the initiative already taken in certain communities, and in the efforts put forth by Dalhousie, St. Francis Xavier, and King's College; our hopes are still further enlivened by the fact of the Mining Society meeting here and now to propose a concrete scheme for the establishment of a technical institute under government auspices. That a suitable beginning may be made with the outlay of a disproportionately large sum of money, is sincerely to be hoped; for there is little indication that the province of Nova Scotia is as yet prepared to commit itself to any very expensive scheme. To set on foot a movement for a million dollar outlay would be to invite opposition and, possibly, ultimate defeat.

I may close by recommending those interested in studying how other countries have begun and what they have accomplished, to procure the *United States Consular Report on Technical Education* for the year 1905.

Halifax Electric Tramway Plant and Steam Engineering.

By Philip A. Freeman, Chief Engineer,
Halifax Electric Tramway Co., Halifax.

(Read 22nd March, 1906).

The subject of this paper, steam engineering, covers such a broad field that I finally decided to confine my paper to certain prescribed limits, avoiding all intricate formula and deductions although both are necessary for the competent engineer.

At times it is somewhat difficult for an engineer to decide upon the type of boiler to use, and in every case the choice should depend upon the nature of the work demanded, whether it is better to use water tube, externally or internally fired, etc. Many plants are able to use with good economy a return tubular boiler, and the selection of a water tube boiler would be of no advantage in comparison with the increased first cost. For railroad work and for that in which the demand for steam is liable to increase rapidly during certain hours of the day, the water tube boiler is by far the best. With a first-class water tube boiler a fireman can carry for a certain length of time a load from 50% to 100% above the rating of the boiler.

In our plant at the tramway station we have seven 250 h. p. Babcock & Wilcox boilers. One horse power equals 30 lbs. water evaporated per hour from 100 deg. Fah. into steam at 100 lbs. pressure, or 34½ lbs. water evaporated per hour from and at 212 deg. Fah.

Four of the B. & W. boilers were purchased during 1902 and 1903 for our new plant, and each of the four has also connected to it a B. & W. patent superheater containing about 330 sq. ft., and giving a total heating surface of 3150 sq. ft., and thus making a total of 280 h. p. for each of the four.

The other three boilers were purchased and used in our old plant previous to the invention of this type of superheater. Boiler pressure carried averages 150 lbs. The temperature of saturated steam which this pressure represents is equal to 370.28 Fahr. Add 100 of superheat and we get a total temperature of 470.28 Fahr. Saturated steam at 500 lbs. pressure equals only 466.57 deg. Fahr. You can readily understand before any condensation takes place at the cylinders that the steam must lose all its superheat, and under ordinary circumstances losses from condensation range all the way from 3 to 20%.

We have also installed for our boilers, fourteen Jones underfeed stokers. In February, 1899, we installed two Jones underfeed stokers, and in November, 1899, eight American stokers who worked with a worm feed. We installed the American for its automatic feed attachment. In 1901 we replaced the eight American stokers with eight of the Jones, and in 1904 ordered four new Jones stokers to complete our new plant, making fourteen Jones stokers in plant. In one year's actual operation with stokers against hand fired in our old plant, we showed an actual saving under same operating conditions in the engine room of 11%. Special care gave 14% as compared with handfiring. Since installing the automatic feed attachment for operating stokers we show an increased saving of 10% over feeding stokers by hand. With hand fired boilers we rebricked the boiler walls four times each year. With stokers, this had to be done only about every nine months. The cost for parts of stokers per year is about one-half what it costs for grate bars under hand fired feeding.

We use a Foster regulator on our steam main to fan engines that regulates the steam pressure within 5 lbs. Also from the shaft of our blower engines we operate our stoker attachment. When steam drops, the Foster regulator admits more steam to blower engine for forced draught. When steam rises to 150 lbs. the regulator cuts off steam and admits less air to furnace and coal to boiler.

We have installed two outside packed plunger feed pumps, 4″ suction and 3″ discharge. We take the feed water from a Cochrane open heater at as near a temperature from 210 to 212 deg. Fahr. as possible. The exhausts from our feed pumps, stokers, and drips from our car house and office heating systems, also discharge into open heater. The open heater receives its supply of water through a regulating valve from induction heaters on each of the main engine exhaust's piping. The average temperature received from the induction heaters equals 90 deg. Fahr. Separate condensers could give water above city water temperature. We are connected to two 6″ city water mains.

Engine Room.—We have installed three Rice and Sargent engines, 18″ x 36″ x 32″ x 150 revolutions per minute, made by the Providence Engineering Co., Providence, R. I.

Style of engines, horizontal, cross compound, condensing, direct-connected. Duties or guarantees:

Steam consumption at 450 H. P. 13—9/10 lbs. steam
" " " 675 " 12—8/10 " "
" " " 900 " 12—25/100 " "

Horse Power at 150 lbs. steam, 28% cut off, 900 h. p.; at maximum cut-off corresponding indicated horse power, 1350. Friction of unit, no load, at 150 rev., 61 h. p.

Generators.—On engine shafts one Canadian General Electric alternating generator: type A. T. B. Class 48 fields; kilowatts 600; rev. 150.; amps. 158; good for 50% overload for one hour.

Railroad.—Three induction motors. Motor end: Type I, Class H. H. P., 330. 514 rev. Cycles, 60. Horse power, 330. Volts 2200, amps. 85; speed 514. Direct current end: Type M. P. Class 6 fields; horse power 225; rev. 514. Form

A. Volts, no load 525, full load, 575. Amps. 391. Also on separate circuits one synchronous set used for motor circuit. Motor end: C. G. E. Co. make. Voltage 2300. Kilowatts 300. Speed 600. Coupled to a direct current generator. Sold by Walker Co. Made over by cutting off ⅓ of its base and shortening and placing a coupling on its shaft. This D. C. armature operated as a belted unit to a 13″ x 24″ x 24″ 150 rev. per minute Robb engine, 1896 to 1902.

Two excitor induction sets, C. G. E. Co. make.

One direct connected steam driven exciter set, made by C. G. E. Co.; engine made by Robb Engineering Co., Amherst.

Four type R., Form A., 100 light series arc oil transformers, prim. voltage, 2200; secondary, 75; amp. 7.5., for street arc lighting, cycler 60.

Also one 50 series arc oil transformer, same as above. We use the latter for commercial arc lighting. 6.5 amps. and 75 volts.

Our Oiling System.—We use one receiving tank, one 200 gallon capacity Cross oil filter, and two house hot-water galvanized tanks. We use the latter as pressure tanks.

Method of Operating.—All dirty oil and water flows into receiving tank from engine room floor overhead. It is mechanically arranged so that on this basis, as water and oil weigh 1/9 less per measure than water, and that by placing a drip water pipe 4″ from bottom of receiving tank and piping it up to 8″ from top of tank, then placing an overflow oil pipe 6″ from top of tank, that the oil overflows to the cross oil filter and the water goes to the sewer. On the bottom of the pressure tanks we have connected a city water pipe that gives about 35 lbs. pressure on our oiling system. The method used to take oil from the cross oil filter or oil barrel into pressure tank is as follows: We have connected to each engine a vertical jet-condenser, from condenser a 1″ pipe main to pressure tanks. To operate, we close the city water supply, open valve on filter or barrel, open the valve to condenser. The vacuum takes water out of tank and the oil takes the place of the water at no cost for power.

Kilowatts per Imperial gallon engine and cylinder oils, 1902, 1903, 1904 and 1905. Engine and cylinder oils used each year:

1902		1903		1904		1905	
Eng.	Cyl.	Eng.	Cyl.	Eng.	Cyl.	Eng.	Cyl.
1147	1024	1140	676	686	622	413	570

TOTAL KILOWATTS.

1902	1903	1904	1905
4908432	5393248	6008290	6084600

KILOWATTS PER IMPERIAL GALLON.

	1902	1903	1904	1059
Eng.	2184.44	4750.1	8758.32	14490
Cyl.	4794.3	7977.02	9659.75	10674

We have on the engine room floor two oil waste presses made of 12″ pipe, about 24″ long, with 1¼″ screw, five threads to the inch, the lever 12″ long from its centre In the old plant we had to press waste by hand to extract the oil. We saved the waste for two months after extracting the oil by hand. Then we placed it in the press. The press saved one barrel of oil, and the waste is used over again without washing. Previous to purchasing the waste press we used five pounds of waste per day. Since then we have used only one pound per day.

Operation and Care of Boilers.—In these days of keen competition it is absolutely necessary to take every precaution for reducing operating expenses, of which the coal pile represents a large percentage. At the plant of the Halifax Electric Tramway it represents 62.5% of the cost at the bus bar. The best of boilers will not take care of themselves, and will generate steam according to the manner in which they are treated.

Shovelling coal into the furnace and keeping a sufficient supply of water in a boiler do not constitute the entire duties of a fireman. He must shovel coal and feed water to the boiler intelligently and study the peculiarities of the steaming properties of his boilers and coal. I might add that no two boilers of the same make, with exactly the same handling, will give the same results.

The proper maintenance of boilers demands that they should be shut down and examined inside and out thoroughly at least every nine weeks. At the tramway plant we shut down every five weeks. The boiler should be thoroughly blown out and cleaned even if solvents are to be used for the prevention of scale. In our plant we use the following method for preventing scale and for cleaning the boilers: The feed is supplied to the boilers through the 6″ city water mains to the induction heater, then to the Cochrane open heater. This has already been described. When the boiler is taken off the line for cleaning and general overhauling, we pump or inject it full of water in which about 20 lbs. of sal-soda have been dissolved, while it is still under pressure and the boiler stop valve closed. It is then allowed to remain 48 hours, when, by this time, the steam pressure has fallen. The blow-off is opened and the boiler emptied. It would seem at first that this would be sufficient to thoroughly clean the boiler, but it is not so. If the feed water valve is slightly opened and the water allowed to flow slowly through the boiler, it will then be thoroughly cleaned, as this slow filtration through the boiler seems to bring with it all the dirt, scale, etc., which was not carried away by the blowing down. Particular care should also be taken that the feed-valves of the other boilers are closed during the time we are filling the boiler with the sal-soda solution, otherwise brass engine fittings, etc., will be seriously affected.

Safety valves are the most delicate part of a boiler, and demand constant care and watching if we wish them to work accurately. My experience with spring safety valves has led me to adopt the rule that all our safety valves shall be quietly lifted from off their seats once at least every 24 hours. If this is not done, I find that a so-called skin forms on the spring and seat, and if the valve is not lifted oftener than once a week it will take considerably more pressure to lift it than that for which it was originally set. Another very serious trouble with safety valves which often occurs is the loosening of the check nut, and if this is not attended to immediately upon the indication of such trouble, the steam pressure will drop and all steam escape into the atmosphere, shutting down the plant. Although, at first, it appears difficult to the engineer or fireman to tighten the nut and set the valve properly, nevertheless, if he understands his type of valve thoroughly, he can accomplish it with his monkey wrench, hammer and chisel, in a very short space of time with perfect safety to himself and plant. If the valve should commence to blow off and steam pressure drop more than 5 lbs., or if the steam pressure should at any time drop more than the proper amount on account of the safety valve blowing off, the engineer or fireman should at once assume that the valve is out of order and should be attended to immediately. If the check nut is loose it can be remedied by turning the valve spindle to the right until the steam stops escaping. Then the cap may be removed and the check nut tightened without difficulty. The boiler pressure should be increased to the same point at which the valve blew off and beyond in order to make certain that the valve will blow off at the proper pressure. This point can be easily obtained by slightly turning the valve in the proper direction.

The above method of handling the safety valve is that commonly used in ordinary practice, but for close regulation the cushion seat should also be raised or lowered according to the range within which it is desired to have the safety valve set. Under no conditions should the safety valve spindle or any of its parts be struck or hammered in order to make it close, as this is a very dangerous practice and is liable to cause more or less serious explosions. This latter precaution of mine may seem to be hardly necessary, yet, in my own experience, I have seen an engineer strike down on the spindle with a piece of 6 x 6 wood with the idea of causing the valve to close. Although at this time of which I speak, no serious results occurred, it might have caused great damage the very next time it was tried.

My experience has led me to believe that boiler explosions are caused by careless and unintelligent attention to the supply of water, and not at all times through inherent defects in the boiler. The guage-cocks should be tried regularly in order to detect any false indications of water in the glass. False indication of water, is not by any means an uncommon occurrence. The sudden breaking of a guage glass causes the valves of the column to be closed, and on replacing the glass, the bottom valve is opened and the upper one forgotten. The glass under such conditions will show false water, as the water will remain in the glass until the boiler is emptied, held in position by the vacuum in the top of the glass. This very case has occurred in our own plant, but any dangerous results were averted by prompt action. In connection with this, I recall an answer given by a chief engineer in the West End Power House, Boston, to the Board of Examiners. He was asked what he would do, if on entering a boiler room he discovered no indication of water in his boiler. He said he would make sure the water was shut off, close all drafts and open his furnace door. On being asked what he would do next, he replied that he would leave the building and watch it from a safe distance.

Pumps are usually given the least care, worked the hardest of the equipment, and at the same time play the most important part in a station. They should be given the same careful attention as the steam engine. We make it a practice to completely overhaul our pumps once a week in order to detect any faults that may exist or are liable to occur. Special care should be paid to the water plunger and valves. Valves should be used which are made to withstand the temperature of the water which passes through them. Disregard for this may cause serious trouble. In our plant we use brass valves in the feed water pump. We use jet condensers, which give an increased economy of 20 per cent. Surface condensers should not be used if possible on account of the deteriorating effect of the oil upon the tubes of the boilers. And if the water is not to be used again in the boilers, then there is no gain, but a loss in installing surface condensers, on account of increased first cost and increased cost of running. Heaters and condensers demand the same careful attention as pumps.

Engines.—The selection of an engine demands the same careful consideration as boilers. Whether high or low pressure, single or compound; high or low speed; steam jacketed, etc. For heavy and variable loads, the compound engine is generally accepted. Large, low speed, compound engines with wide expansion, are generally accepted as more efficient than those with only a single cylinder. This is clearly shown by the results of tests on the compound engine. When this engine was run as a single engine it used 24 lbs. of steam per h. p., and when run as a compound engine with the same load steam pressure and under the same general conditions, it only used 20 lbs. steam per h. p.; thus demonstrating that the compound engine was 20% more efficient than the single engine. Especially are compound engines more efficient with high steam pressures.

Engines for street railroad work, and other work imposing sudden change of load and unusually heavy strains, should be built with heavy forged cranks, and wheels of about double the usual weight, and with all the parts in such proportions as will give perfect work under the most trying conditions. Governors for this work must be especially good, and must respond to sudden changes of load and continue to regulate closely under all circumstances. The variable cut-off on low pressure cylinders is also a strong point in such engines for this work, as it ensures quick work, quick regulation, and high economy. Under variable loads the regulation of our Corliss engines is within 3 per cent. giving the greatest satisfaction, and up to the present time three of this type of engine have been in constant use on our total output, railroading and lighting since September, 1902, when our first Corliss unit started. November, December, January and February, we have to run all three engines every evening except Sunday. Each engine runs 30 hours alternately, and the day load varies from ⅛ load to 50 per cent. overload on account of the variable railroad load.

An engine should be indicated every three months on account of the wear and tear of the parts, and the variation in the valve rod connections. Our engines were first set by hand and then by the use of the indicator in our old plant. This was done and a saving of 19 per cent. was shown.

On taking charge of our old plant September, 1895, the boilers were carrying nearly their full capacity. By indicating the engines and setting valves properly we were able to increase our engine load 50 per cent. and only increased our boiler load 10 per cent. All this simply goes to show that the indicator should be used freely and intelligently in order to effect the greatest economy.

The profitable use of steam jackets is a much discussed question, and many engineers disagree. My experience with nine 1000 h. p. engines, steam cylinder and head jacketed engines has led me to doubt the advisability of using the steam jacket on the cylinder barrel. I advise jacketing the cylinder heads.

In my opinion the extra cost of maintaining the extra steam piping and the liability of damage to the cylinders more than counterbalances the saving obtained by steam jacketing the barrel of cylinder. If an engine cylinder has cooled down, the greatest care must be taken in re-heating the cylinder through the use of the steam jacket or else a cracked cylinder will result on account of the unequal expansion. Such an accident has occurred under my own observation, and it has not made me very enthusiastic in the use of steam jackets on barrel of cylinders. But I strongly advise steam jacketing the cylinder heads.

If I did not consider that I have already occupied my share of your time, I would like to take up the subject of engineering in a more technical manner, giving figures to back up my statements. Also the proper handling of coal, chimney draft, etc. Also the switchboard at the tram plant. That I have not mentioned. It is one of the safest and best equipped in the country, and has but to be seen to be admired. But the latter subjects demand a paper in themselves, and can hardly be treated sufficiently in a paper of this kind.

I wish to thank the members of the mining association for their attention, and if the paper has suggested any questions which might be asked, I shall be only too glad to try to answer them.

DISCUSSION.

DR. POOLE.—I move a vote of thanks to Mr. Freeman for his very valuable paper. It gives us his experience with a modern plant. The economies he has shown certainly warrant the cost that was undertaken and entailed.

J. H. AUSTEN.—I have much pleasure in seconding the vote.

G. W. STUART.—One thing that struck me as remarkable, is the saving of fuel with mechanical stokers and also the saving in the linings.

PROF. SEXTON.—I think if Mr. Freeman could give us an idea of the cost per horse power per year and the results, it would furnish us with valuable information. It is a most admirable up-to-date plant.

H. PIERS.—I would like to ask Mr. Freeman if he finds that the Halifax water produces boiler scale: and if so, what method he uses to counteract the action of the water?

P. A. FREEMAN.—Yes, the Halifax water produces scale, but is not as injurious as Dartmouth water. We place a bag of common lime in a tank containing 35,000 gallons of water, and draw from that. We counteract the influence of the scale by washing the boiler out every five weeks with sal soda. In the Acadia Sugar Refinery they were losing thousands of dollars in boiler tubes while we have never lost a tube.

G. W. STUART:—Would the lime counteract the effect of vegetable acids?

P. A. FREEMAN:—Yes. Since the sugar refinery company used lime in its water, it has had no trouble with its boilers, and they are in better condition now than they were ten years ago.

The vote of thanks to Mr. Freeman passed unanimously.

Shaft Sinking in Quicksands and Boulders

By George W. Stuart, Truro, N. S.

(Read 23rd March 1906)

During the years of 1865–68 quartz boulders, rich in gold, were discovered on the east side of the Killag River, a tributary to the Sheet Harbor waters in the eastern part of Halifax Co., N. S. The place was in the heart of the woods, six miles from any road.

So very promising were these finds of rich drift quartz, that one Leopold Burkner, who was operating extensively in Waverley, risked the expense of portaging into the district the material for a ten-stamp mill, which was never erected, however, because of failure to find the rich lead or any leads of value. After Mr. Burkner's departure, spasmodic efforts were made by different parties to find the lead that shed the rich drift, all of which however resulted in failure.

In 1884, with some friends associated financially with me, I acquired the areas these rich boulders were found on, and the surrounding areas as well. After a careful examination of the place, and considerable surface explorations, and other general preliminary work, I came to the conclusion that the lead so long sought for was near the centre of a wet swamp, some six hundred feet wide and half a mile long, extending from a lake, called the Black Duck, toward the Killag River, longitudinally with the rock strata, east and west.

Several attempts had been made to sink in this swamp, only to be abandoned at a few feet in depth. At the lower end of the swamp next to the river, in trenching for draining purposes, we found the remains of an old beaver dam. I would judge it to be centuries old, as it was covered by several feet in depth of surface chiefly decomposed vegetable matter, yet some of the wood, white poplar, was yet quite sound, and still showed the chisel-like marks of the beaver's incisors.

We began the work of sinking with hand-gear. After going through five or six feet of dark coffee-coloured peat, which later proved to be excellent for steaming purposes when dried, we encountered a bed, or lair, of water-worn boulders. After going through this rock-bed we were in quicksands and boulders of varying sizes from that of a man's head to many tons in weight, with heavy water also to contend with. We soon found the ordinary method of sinking a surface shaft in bad ground, viz., by putting in setts and driving piling, could not bo successfuly pursued there, because of much water, large boulders, and the lively nature of the sands. The freezing or compressed air processes were out of the question in such a remote place. I therefore determined to adopt the caisson system.

The first caisson we built was 14 feet long by 7 feet wide and 10 feet high, with three setts, made of 6 inches by 9 inches spruce timber and planked with 2½ inches spruce, close joints. It was built 3 inches smaller at the top than the bottom: the plank ends projecting 6 inches above top sett. The windlass gear and sump box were placed on the top, and operations began inside. As the excavating proceeded, the caisson, with the added weight of the windlass gear, sump box, and men, gradually lowered, until the top was level with the surface. We then built another caisson exactly the same as the first, except that it was the thickness of the planking smaller, thus permitting it to telescope the first one 6 inches, therefore the bottom of the planking rested on the top sett of the first one. Placing the gear on the top as before, we resumed work, which we found, however, proceeded very slowly.

Working only day-shifts, we often found in the mornings that the quicksands had risen almost to the level of the previous morning. We frequently encountered large, rounded, smooth boulders, altogether too large to lift with windlass gear, and yet it was almost impossible to drill them for blasting because of the rising quicksands. The workmen had to lay boards to stand upon, otherwise in a few moments they would be fast in the sands and could only be relieved by slipping their boots. We found the number of cubic feet actually excavated and hoisted was ten times greater than the cubic feet of space made within the inclosure. We also discovered that the surface, for a radius of many feet around the shaft, was gradually lowering, and we found that our caissons, notwithstanding the relief taper began to stick fast. We then laid heavy timbers across the top of the caisson and built scaffolds on them and ballasted the scaffolds heavily with stone. By this means we managed to reach the depth of the second caisson. We then built a third caisson and placed it on top of the second one; but we found, on resuming work, that the rising of the sands, and the pressure of the large boulders that crowded in upon the sides of the caissons, stopped the work completely. We were now obliged to cease hand operations, and procure and transport thither a a small portable steamplant, to which we attached a small hoisting gear and a suction pump, which, by close attention, worked well in pumping the sands with the water; but our caissons still stuck fast, held in the grip of the large boulders on either side, that had crept in upon us by the ever moving, stealthy, and relentless enemy, the sand. We dug, and pumped and hoisted almost fiercely, and we piled more ballast on our scaffolds, but our efforts were in vain; we were held as solid as a ship in the midwinter Arctic ice, until the sides of our caissons groaned and showed serious signs of collapsing from the great pressure. But Nova Scotia prospectors are resourceful, so we determined to attack our invisible outside enemies from the inside. By carefully sounding the side of the caissons with a hammer, we were able to locate the bearings of each of the attacking boulders. We then, with an auger, bored through the planking, and so introduced hand-drills and bored into each rock from

12 inches to 20 inches, according to their estimated size, then charged the holes with dynamite, and connected with long fuses. We then cut timbers to exactly fit endways between the sides of the caissons, and drove them into place, until there was a solid wooden wall to resist the force of the blasting. It was a venturesome experiment, but it was entirely successful. When the boulders were shattered by the dynamite, our caissons were relieved at once. Once again we had to repeat the operation before we reached bed-rock, with the same result. We found the surface of the bed-rock somewhat rough and uneven but we were able, with dry pine blocks, and tough moss for caulking, to hold at bay our ever-on-the-alert enemy, the quicksands, thus enabling us to sink comfortably in the rock, and then to crosscut.

Fifty feet north of our shaft we found the lead the rich drift had come from, and we were not dissapointed; its value warranted the efforts to discovit.

It may be mentioned that we found the bottom of the pit, between the decomposed vegetable matter and the top of the bed of rocks, was a living mat of roots, from an inch to two inches in thickness, which was evidently in process of growth. I examined it very carefully. It was composed of a wire-like growth of roots varying very little in size—a little larger than rabbit-wire. We could raise yards of it, all of it holding together like a mat. It occurred to me that many of the bogs that are seen raised above the level of the surrounding country, might have originated in this way, the growth being from the bottom instead of from the top.

DISCUSSION.

DR. POOLE.—At what depth were the roots?

G. W. STUART.—From four to six feet from the surface. I think the peat was completely decomposed. The ash of the latter was perfectly white with no sand at all. I concluded that the growth of the peat was from the bottom instead of from the top. There was an absence of any sediment whatever. It was all roots. All the peat cut in Ireland has from seven to ten per cent. of sand in it.

R. H. BROWN.—Were the roots alive, and did they seem to have any connection with the peat?

G. W. STUART.—Yes, the roots were alive, but they had no connection with the peat. They rested on the bed of rock.

PRESIDENT HAYWARD.—On the boulders?

G. W. STUART.—Yes.

F. H. MASON.—It is remarkable that the roots were green. The roots could not have been connected with anything living on the surface?

G. W. STUART.—No.

F. P. RONNAN.—You were not able to determine the nature of the growth?

G. W. STUART.—No, I have often regretted that I did not save a section.

PRESIDENT HAYWARD.—Did the boulders continue all the way down to bed rock?

G. W. STUART.—Yes.

PRESIDENT HAYWARD.—In reference to your coffer-dam, after you got down a distance and encountered boulders, had you built another one inside, a little smaller, would you not have overcome the difficulty you encountered by drilling and blasting the rocks?

G. W. STUART.—No. The quicksand would come between the outer and inner ones and stop us completely.

PRESIDENT HAYWARD.—I had an experience about twenty-five years ago in Maine. I was working in twenty-five feet of quicksand, loose sand, and we adopted the same principle as you did by building a caisson, putting the windlass on top, sinking it down and starting a shaft. It was afterwards necessary to build a brick chimney one hundred and twenty or one hundred and thirty feet in height.

F. P. RONNAN.—What distance was it to bed-rock ?

G. W. STUART.—About thirty feet. I think some of the boulders that stopped our work had crept in with the moving sands as much as ten feet, perhaps more. They were gradually creeping in on us as we went down.

Ankylostomiasis: "Miners' Anemia": a Resume of European Experiences.

By Francis William Gray, Assoc. Mem.
Inst. Mining Engineers.

(Read 23rd March 1906)

The mining population of Europe, particularly that portion engaged in coal mining, has suffered considerable inconvenience, both physical and pecuniary, from the prevalence in recent years of a disease variously known as ankylostomiasis, miner's anemia, hookworm disease, etc. This unpleasant experience has been dearly purchased, and could have been avoided had any regard been paid to sanitary conditions underground. The following notes have been collated from various European sources, as a result of somewhat extended reading on the subject. They are written purely from the standpoint of the mining engineer, and the fact that only a few members of the medical profession have any intimate acquaintance with the technique of mining, or actual physical conditions underground, must be the writer's excuse for venturing on a subject so very largely medical, but which from its dependence on local conditions and systems of coal extraction, and considering its serious effects on the health and general prosperity of the miner, is of vital interest to the mining industry in general.

Recent English literature on the subject is not very extensive, as the subject has not been so forcibly brought to the front as it has been in France, Germany and other European countries. The principal authority in England is Dr. J. S. Haldane of the Home Office, who published a blue-book in 1902 in connection with the outbreak at Dolcoath in Cornwall,[1] and one at the end of 1903, detailing the results of a visit to the infected districts of the continent.[2]

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1. Home Office Cd. 1318, 1902. Price 4d.
2. Home Office Cd. 1843, 1903. Price 2d.

Several papers on the subject will also be found in recent numbers of the Transactions of the Institute of Mining Engineers.

An excellent handbook is published by the "Colliery Guardian" at a nominal cost, which has had an extended circulation, and a series of lucid papers on the disease are now appearing fortnightly in the same paper.

In the United States much attention has been given to the study of the "hookworm disease" or "uncinariasis" (which is for all practical purposes indentical with ankylostomiasis) by Dr. Ch. Wardell Stiles of the Hygienic Laboratory at Washington, who in 1903 issued a report upon "The Prevalence and Geographic Distribution of Hookworm Disease in the United States"[1] attached to which will be found a very comprehensive bibliography of general literature relating to ankylostomiasis in various parts of the world.

Recent continental writings are more voluminous, and apart from the monumental works of Perroncito, Leichtenstern, Looss and other eminent European authorities, which are purely medical treatises, reference may be made to the published report of the commission appointed by the German authorities to enquire into the Westphalian epidemic, and to various articles that have been contributed by medical correspondents to "Glückauf," the semi-official organ of the Westphalian coal operators. But the most recent and perhaps the most important contribution from the standpoint of the mining engineer is a work recently published by Drs. A. Calmette and M. Breton of the Pasteur Institute at Lille,[2] which covers with painstaking detail the whole subject, and as the authors state in their preface, was in part written especially for the benefit of the mining profession. Attached to the work is a comprehensive collection of official documents issued in various countries, and a chronological index to all literature relating to ankylostomiasis from

[1] Hygienic Laboratory Bulletin, 1903, No. 10.

[2] L'Ankylostomiase (Anémie des Mineurs), Masson et Cie, Paris, 5 fr.

1879 to the present time. The work has received the fullest appreciation in England and on the continent, and the authors have been honoured at the hands of several learned bodies in recognition of their labours. It is to be hoped the book may be published in an English translation. A very free use of the text has been made in the following notes.

As will be gathered from a study of the natural conditions most favorable to the life cycle of the ankylostome, it is chiefly to be found in tropical and sub-tropical countries, and is more especially associated with low-lying and damp localities. In the temperate zones it will as a rule be found only where these conditions are artificially produced. Broadly speaking the parasite will be found to occur normally on either side of the equator, between the fortieth parallels. Within these limits the disease may be endemic, and the population may be affected as a whole, as in Egypt where it is stated no social class is immune, or in Porto Rico, where practically every inhabitant is more or less infected. Outside these limits the occurrence of the disease in anything approaching an epidemic form, will as a rule be incidental to industrial operations in the course of which an artificial environment is created which is favourable to the propogation of the parasite: such conditions as for instance occur in the neighborhood of large brick kilns, in hot, moist, unsanitary mines, and in deep tunnelling. The persons affected therefore, are likely to belong to distinct industrial classes, and the disease will assume the aspect of a trade malady (Berufskrankheit).

The disease is not new, and Sandwith states the symptoms of a malady described in an ancient Egyptian papyrus, written so long as 3,450 years ago, leave no doubt that this sickness was well known to the physicians of that far off day. The first recorded description of the ankylostome itself was given in the year 1838 by Angelo Dubini, who discovered the worms in the intestines of a young Italian peasant who had died in the hospital at Milan.

According to the various authorities cited by Dr. Calmette, anklostomiasis is endemic over the whole of Egypt, Abyssinnia, Ethiopia, along the shores of the Red Sea, and in fact over the African littoral generally. It is fairly widespread among the natives of British Central Africa,[1] which considered in connection with the fact that ankylostomiasis is common among the agriculturists of southern China, suggests the advisability of preventative measures in the deep mines of the Rand. In Asia it is found over that portion of the continent extending from India, through Cochin China and Siam to China and Corea. It is found in Japan, particularly round Nagasaki, in Formosa, and throughout the whole of the Malayan Archipelago. In Australia it exists in the northern portion of the island, especially in Queensland. In America it effects practically all the continent lying between the fortieth parallels. The American species differs in some respects from the Old World ankylostome, but these differences are only minor, precisely the same symptoms being produced by their presence in the human body. Full particulars of the extent of hookworm disease in the United States may be gathered from Dr. Stile's report before referred to. Dr. Stiles made a visit to the Southern States, in the winter of 1902, studying the disease on the ground in the Carolinas, Georgia and Florida, and found the disease widespread, particularly in sandy districts. In his report he writes: "Speaking in general terms, however, the facts at my disposal at present seem to indicate that taking the southern Atlantic States as a whole, uncinariasis must be considered as one of the most common and widespread maladies. Among the whites of the rural sand districts uncinariasis is apparently the most common disease found." He further states: "In all probablility further study will show that in Mexico, Central America and parts of South America, hookworm disease is more important and more common than in the United States." Speaking of the economic bearing of the hookworm disease, Dr. Stiles draws a very depressing picture of the poverty and mental backwardness among the "poor whites" of the infected districts, and to quote further he says: "Considering the subject in the light of all I saw on the trip, and taking what I believe to be a conservative view of the subject, I find it exceedingly difficult to escape the conclusion that in uncinariasis, caused by *Uncinaria americana* we have a pathologic basis as one of the most important factors in the inferior mental, physical and financial condition of the poorer classes of the white population of the rural sand and piney wood districts. This sounds like an extreme statement, but it is based on extreme facts."

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[1] Journal of Chem. Met. & Min. Soc. of S. Africa, 1901, vol. iv., pp 256—260. Walter C. C. Pakes.

In Europe, although known to exist since the date before mentioned, the disease never assumed a serious aspect until the alarming outbreak in the St. Gothard tunnel in 1879, from whence it is extremly probable the infection was carried to other parts of Europe by the exodus of the workmen at the completion of the work. Ankylostomiasis is said to be endemic over a large portion of Italy and the low-lying plains of the Danube, and the Theiss in southern Hungary. The condition of the sulphur miners caused by the extensive infection that exists in Sardinia is truly deplorable. More detailed reference will be made to the disease as manifested in the coal mines of France, Germany and Hungary, at a later stage of these remarks.

In England an epidemic of a mysterious nature broke out at the Dolcoath tin mine in Cornwall, which was eventually traced to anklyostome infection, and this also will be dealt with more fully later.

The *Ankylostome duodenale* is a parasitical worm belonging to the Nematode order (thread-like) The adult female is approximately ½ in. in length, the male being shorter and thinner, and easily distinguishable from the female by a characteristic umbrella-like caudal process surrounding the genital organs at the tip of the tail. The adult worm of both sexes is provided with a formidable suctoral apparatus, consisting of a circular mouth opening, furnished with four incurved teeth, leading to a strongly muscular esophagus which acts like a pump, the whole forming, to quote Dr. Calmett, "a veritable cupping-glass." The name of hookworm popularly applied to the ankylostome is not derived, as would at first sight appear, from the hooked teeth with which it is so liberally provided, but from the fact that the head of the worm is bent round like a hook, the mouth being on the under surface.

The natural habitat of the adult ankylostome is the small intestine of man. Here the female lays her eggs in enormous numbers, commencing to do so the day after impregnation. The eggs are very minute, about $\frac{1}{400}$ inch by $\frac{1}{700}$ inch, oval in form, and delicately transparent. They are provided with an inner membrane which in conjunction with the concentrated fluid interior exerts a great osmotic pressure, and renders the eggs almost impermeable, consequently they possess extreme powers of resistance to outside agencies. They pass out of the body with the fæces, unusually partially developed, but development to the larvel stage in the body itself is prevented by the natural heat and the lack of oxygen in the intestinal passage. After leaving the body the conditions necessary to hatch out the larvæ are warmth, moisture, and the presence of oxygen. All these conditions must exist together, and if any of them are absent development will not take place. Below a temperature of 68 degrees Fahr. or above 98 degrees Fahr. development is retarded or entirely prevented, Given favourable conditions, however, the eggs will hatch out very quickly, the time varying from several hours to two days, according as the conditions are more or less suitable. The young larva is very active, and before hatching may be observed coiling and recoiling itself with extraordinary rapidity within its shell. When it succeeds in breaking out and emerges as a free larval worm, it commences to feed voraciously on the fæcal matter surrounding it, and grows rapidly, changing its skin on the second or third day. At the end of from four to six days it commences to secrete a vitreous transparent fluid, gradually loses its mobility and becomes rigid, and within four or five days is completely enveloped in a smooth yellowish chitinous capsule, impervious to water, which enables the larva to resist with ease physical and chemical influences that would have been fatal to it when newly hatched. The larva at this stage possesses remarkable vitality, and has been observed by Looss to live for a period of 300 days when immersed in water, which is said to be a medium well suited for the preservation of the encysted larvæ. They have also been known to resist desiccation prolonged over five days.

This stage completes the development of the ankylostome outside the human host, and it awaits an opportunity to gain entrance to the body. It was formerly supposed the larva of the ankylostome could develop into a sexually mature free rhabdite capable of producing eggs and disseminating infection outside of the human organism, but this theory is not now accepted. The encysted larva may gain entrance to the body either through the mouth by swallowing or through the skin. The possibility of this latter mode of infection was for some time disputed by several medical authorities, especially in Germany, but the extensive researches of Dr. Looss, of Cairo, whose conclusions are endorsed by Dr. Calmette and Dr. Haldane, have proved beyond doubt that the encysted larva can penetrate the pores of the skin, pass with the blood stream to the lungs, and from there find its way into the esophagus and finally the stomach. A peculiar feature of the recent epidemic at Dolcoath, Cornwall, was the prevalence of pustular cutaneous eruptions known by the miners as "bunches" and many authorities record instances of cutaneous infections accompanying ankylostome infection. These eruptions occur more particularly on those portions of the body which are exposed to contamination by dirty water or mud, the chief vehicles of infection. The encysted larva, being able to resist a comparatively long period of dryness can also, according to Calmette, be transported by air currents, and may find entrance through the respiratory organs, but this mode of infection is probably exceptional.

When the encysted larva reaches the stomach the protective covering of chitin is softened and loosened, permitting the worm to disengage itself from its envelope, for which it has no longer any need. Dr. Calmette remarks that the envelope is not dissolved by the gastric juices as has been supposed, but merely relaxed, he having found both the pancreatic and intestinal juices quite negative in their action on the material of which the covering is composed. After remaining in the stomach sufficiently long to divest itself of the covering —the stay there never exceeding fifteen hours—the liberated ankylostome passes into the duodenum. Here its growth is at first slow, but after a week a provisional mouth cavity makes its appearance, which is gradually modified, until finally the complete dental apparatus with its four curved teeth is perfected, and in from four to five weeks after the infection the sexually perfect adult ankylostome is evolved, and another cycle commences. The worms attach themselves by their teeth to the mucous lining of the intestines, in which they bury their heads deeply; sometimes, indeed, they penetrate to the submucuous membrane and exist in a sort of blood-bath, They do not remain in the same spot all the time, but move about from place to place, so that the bites are more numerous than the actual number of the worms. If no fresh infection occurs, the worms will decrease in numbers and gradually die off, but they have been known to live from five to seven years in the intestines.

It does not appear that the *Ankylostome duodenale* can exist in any other host than man. Various experiments have been tried to infect horses, mine rats, rabbits, dogs and mice with preparations of ankylostome larvæ, but in every case with negative results. Dr. Bruns, of the Gelsenkirchen Institute of

Bacteriology, before the Berlin conference on ankylostomiasis in 1903, detailed some experiments on higher anthropoid apes brought direct from the tropics. The animals were given food containing the encysted larvæ of the ankylostome, and microscopical examination of their fæces, after the lapse of the ordinary incubation period, revealed the presence of eggs in no wise to be distinguished from those contained in human fæces. The eggs developed to young larvæ, also exactly resembling the ordinary young ankylostome, but the adult worms were quite dissimilar, being unencysted, longer, more active, and incapable of reproduction. The ankylostome would appear, therefore, to possess an organism highly specialized for life in the human body, and to be incapable of reproducing itself except in the manner previously described. The worms cannot reproduce inside the body, and, therefore, for every adult worm present the host must have absorbed an encysted larva. Direct infection from person to person is not possible, actual contact with contaminated matter being necessary to contract infection.

The symptoms accompanying the presence of large numbers of ankylostomes in the human organism, and constituting the diseased condition known as "ankylostomiasis," bear a marked resemblance to those accompanying pernicious anemia and the chlorosis of young women. The skin of the face becomes pale, assuming a waxy appearance as the disease advances; the mucous membrane of the lips and the inner surface of the eyelids become bloodless, and the tips of the ears have a greyish hue. Pains are experienced in the region of the stomach, sometimes accompanied by distention of the abdomen. Diarrhœa is a feature of the disease, originating, no doubt, in the intestinal irritation set up by the worms, and this alternates with an obstinate constipation. The fæces present often a brownish or reddish cast owing to the bleeding of the intestines from the bites of the worms. As in all diseases of this nature, the appetite is capricious and irregular, sometimes abnormal and at other times poor. The taste becomes perverted, the sufferer evincing a desire for such things as pickles, salt and dirt. Dr. Stiles makes extensive remarks on this feature, which occurs very frequently among the "poor whites" of the Southern States, where he found cases of "sand-lapping," "resin chewing" and "dirt eating," and he remarks that this perversion of taste may be "classed with the chewing of slate pencils, resin, coffee, sucking of lemons and salt, &c., as an abnormal appetite due to the anemia and abnormal condition of the intestinal tract."

The effected person suffers from dizziness and palpitation, and from shortness of breath on the least exertion; he has frontal headeaches, becomes extremely sensitive to cold and loses all desire for work. In the final stages of the disease dropsy may supervene, and the sufferer is reduced to a condition of general debility that renders him an easy prey to other diseases. In some cases effections of the skin may be present as before mentioned, and a bronchial catarrh has been noticed by Belgian doctors, as sometimes accompanying the other symptoms. These latter symptoms are probably due to the irritating effect of the larvae when effecting their entrance through the skin, but the main symptoms are, without doubt the result of the anemia consequent on the altered condition of the blood, which is the most prominent result of the presence of the worms. The proportion of the red corpuscles in the blood is largely reduced, and the distinctive feature is the marked increase in the proportion of eosinophile leucocytes, colourless corpuscles of the blood, so-called from the fact that they are readily stained by eosin, and under the microscope afford a means of diagnosis that has been found of value.

The symptoms, of course, are progressive, and are not the same in all classes, the resistance of the individual playing an important part. The severity of the anemia is dependent on the number of the parasites present in the intestines and the length of time they have been there, modified by the powers of resistance possessed by the person attacked. Some persons may carry numbers of the worms, quite unconscious of the fact, and to all appearance possessing good health. This fact led the German doctors to separate their ankylostomiasis patients into two classes—"worm-carriers" and "worm-sick." The first-named class included those persons whose dejecta contained the ova of the ankylostome, but who were not apparently unhealthy. The second class was composed of those in whom the ravages of the worms had so far advanced as to assume all the characteristics of a disease, the patient being visibly anemic, and exhibiting plainly the peculiar symptoms of ankylostomiasis.

The blood-sucking propensities of this creature, while sufficiently serious, do not altogether explain the marked alteration which takes place in the character of the blood, and several authorities incline to the opinion that the parasite secretes a toxin which causes this altered percentage of the blood constituents. Sandwith, referring to fatal cases of ankylostomiasis that had come under his observation, states :—

"The actual cause of death was exhaustion from utter absence of rallying power. It is difficult to believe that the pathological effects are induced only by hemorrhage from the daily suction of scores or even hundreds of worms. In addition to this loss of blood we have general thickening and degeneration of the duodenum and jejunum, and consequent interference with normal digestion ; then non-assimilation, and eventually a process of slow starvation. It is also worthy of note that there may be in prolonged cases some self-poisoning from the great number of bites in the intestines containing ill-digested and, perhaps, decomposing food."

In prolonged and severe cases of ankylostome infection the outward symptoms of paleness, etc., are sufficiently obvious, but, as before mentioned, not all "worm-carriers" exhibit outward symptoms, and the recognized and, perhaps, the only absolute test for the presence of the worms is microscopical inspection of the fæces for the ova of the worms. Dr. Stiles gives a quick and ready method for preliminary diagnosis of suspected cases. About an ounce of fresh fæces are placed on a sheet of white blotting paper and allowed to stand for from twenty minutes to an hour. In medium or severe cases of ankylostomiasis a reddish brown stain will be left on the blotting paper. The blood examination for ankylostome infection is based on the proportion of eosinophiles. The finger of the person under examination is pricked with a needle, and the resulting drop of blood is smeared on a slide, which before examination under the microscope is treated with eosin dye. This method is quicker and less repugnant than fæcal diagnosis, aud while not absolute, as there are other intestinal parasites which have a similar effect on the blood corpuscles, it is still very accurate, and affords a rapid and cleanly method especially applicable to the preliminary examination of large numbers of men. It has been largely used in England by Dr. Haldane in connection with his enquiries in the mining centres of that country.

Thymol and male-fern are the two drugs usually administered to expel the worms. Thymol is preferred by the American and English profession. while in Germany extract of male fern has been very generally used in connection with the Westphalian epidemic, The use of these drugs is not unattended with danger where the patient is weak, but, as a rule, two and rarely three doses are sufficient to expel the worms. In some cases, however, repeated doses will not do this, more especially where the infection is of long standing. After the parasites have been removed the debilitated constitution of the patient requires to be built up by means of a nourishing diet and the administration of iron in some form. Where the disease has not progressed too far the patient will usually make a rapid recovery, but after a certain stage the health remains permanently impaired, even when the worms have been all expelled.

Westphalia.—Ankylostomiasis has been known to exist in the mines of Westphalia since 1886, and during the years 1892 to 1895 enquiries were being made at the instance of the German department of mines, but no further steps were at that time deemed necessary than the examination of foreign miners, more especially those who came from the brickfields of Belgium, and a superficial examination of the underground employees at the various mines by a medical officer as the men filed past on pay days. That there was no reason for alarm will be gathered from the figures following. Up to 1899 these show a steady decrease in the number of cases, but it will be noted that a very rapid rise took place in 1900.—

1896,	107	cases in	16	mines	=	6.4	per 10,000.	
1897,	113	"	32	"	=	6.2	" "	
1898,	99	"	24	"	=	4.9	" "	
1899,	94	"	27	"	=	4.4	" "	
1900,	275	"	42	"	=	11.7	" "	
1901,	1030	"	65	"	=	40.6	" "	
1902,	1355	"	69	"	=	52.9	" "	1st 9 mths. only.

It is very generally admitted that the introduction by the government in the early part of 1900 of compulsory water sprinkling in all dusty and fiery mines, explains to a very large extent this sudden increase in the extent of the infection. The object of the sprinkling order was to lessen the danger of fire and dust explosions, which in the past had caused the loss of many lives, and this object was achieved. The order was very thoroughly carried out, pipes being laid all over the mines, provided at convenient distances with spraying nozzles which distributed water in the form of a fine dust. Before and after every shot the working places were sprayed most effectively, and the whole mine was filled with moisture. Some persons deny that the sprinkling order was altogether responsible for the sudden increase, but their exact coincidence is at least significant. The majority of the coal seams in Westphalia have a very high pitch, and one result of spraying was that the surplus water flowed back into the levels, carrying with it in a diluted state, portions of any fecal matter with which it came into contact. Dr. Tenholt the chief medical officer of the Knappschafts-Verein, stated before the Berlin conference of 1903, his belief that the increase in the number of cases was due to the sprinkling, which diluted and distributed the fæces and acted as a vehicle to carry the ova to every part of the mine, besides providing the moisture so necessary for the development of the larva from the egg. Further, the surplus water in many instances drained into a central sump, and was used over again for sprinkling with the result that the eggs and larvæ were distributed broadcast over the mine, thoroughly infecting it in every part.

The oversight and general responsibility for the general health of the miners of Westphalia is vested in the hands of a body known as the Knappschafts-Verein, which is a compulsory provident society under government supervision. It is supported by contributions from the miners and by grants from the coal operators, and has its own medical officers. At the urgent request of the coal operators, who were justly alarmed at the serious spread of the infection, this body in 1902 appointed a special commission, which has since been actively engaged in fighting the disease. It formulated special rules and inaugurated a vigorous campaign of education and prevention. The use of sump water in sprinkling was forbidden, and arrangements were made for extended medical examinations of personnel at the infected collieries. Up to the time when the commission took over the general direction of the measures adopted for the extirpation of the infeation, the medical examinations, as before mentioned, had been made on pay days and were very superficial. Such persons as the eye of the doctor picked out as showing anemic symptoms were sent to hospital for examination and treatment. It began, however, to be realized that this procedure was not sufficiently far-reaching, and that while the distinction between "worm-sick" and "worm-carriers" was absolutely correct from a clinical point of view, the worm-carrier, even though apparently healthy, was a focus of infection and a menace to the health of those who worked with him. The board of mines at Dortmund, issued an order calling upon the coal owners to arrange for a microscopical examination of the faeces of, at least, 20% of the underground force, and where infection was known to exist or was revealed by this partial equamination, the faeces of every person employed underground were to be seperately examined. By this means it was hoped to obtain an exact knowledge of the extent of the infection. One of the many difficulties to be overcome was the provision of a sufficient number of examiners, as owing to the similarity between the eggs of the ankylostome and those of other intestinal worms a special training was necessary before the microscopists became expert, and it was further found that 50 slides a day was all that one man could examine, owing to the very exacting nature of the work. It is hardly necessary to enlarge on the elaborate organization and apparatus required, and the enormous amount of not overpleasant work that this task involved, but the results obtained fully justified the undertaking. Official figures given in "Gluckauf," in November, 1903, showed that out of a total of 188,730 men in the Dortmund district, 17,161, or 9.09%, were the victims of ankylostome infection, the percentage of infected men to the total employed underground ranking at different collieries from 2% to 28%.

In order to afford these men proper treatment, portable hospitals were provided by the Knappschafts-Verein at the various collieries. To these hospitals were sent all those men whose dejecta contained worm eggs. They were put through a course of treatment with extract of male fern, and about 97% have been discharged from hospital as cured. Before being allowed to resume work underground, these men must hold a certificate that they are worm free, and must present themselves for another examination within six weeks. In a small percentage of the cases treated—1.5%—the extract of male fern has failed to drive out all the worm, and as further doses might endanger the health of the men they are discharged "uncured," and not being allowed to work underground must find surface employment.

Adequate closet accommodation underground is enjoined by law on all mine owners The closets are usually iron pails, strongly made with tightly fitting lids, and often with ingenious arrangements to prevent the soiling of the seat. Any man who defecates in the mine and does not use the closet provided, is, if discovered, sent to prison without the option of a fine. The pails are looked after and kept clean by men specially detailed to do this work. In the night time men collect and load the pails on to special trucks, on which they are despatched to the surface, where the pails are emptied, washed out with hot water, and finally sterilized in a steam cylinder before being sent down below ground again. At some Westphalian collieries the management have provided water-closets of a rather elaborate nature on the surface for the use of the employees before descending the mine This commendable innovation has been found to work satisfactorily in practice, and is becoming more general.

Numerous attempts have been made to disinfect the mines by the use of such substances as lime, carbolic acid, permanganate of potash, sulphuric acid, &c., but without success. The disinfection of a mine whose various roadways total up to, perhaps, one hundred miles, is obviously impracticable, not only on the score of the cost, but because in order to be effective the disinfectant must be applied, at least, daily. Further the encapsulated larva is very difficult to kill, and can live for twenty-four hours in a 1-in-500 solution of corrosive sublimate. Those substances which would effectually kill the eggs and larvæ are mostly inadmissible in the confined airways of a mine on account of their corrosive nature, and their strong odour, and it was finally realized that attempts to disinfect the roadways of a mine were quite fruitless and the idea was abandoned entirely, all efforts being concentrated on the prevention of the entrance of new infection.

Thanks to the severe measures adopted and the energy displayed in their promulgation, the Westphalian epidemic has now been got into very manageable limits, and will be steadily stamped out, although it will be, probably, several years before it can be regarded as extirpated. Probably in no other country could such drastic laws be enforced as were passed in Germany in regard to this disease. Considerable dissatisfaction was aroused among the miners, whose freedom was restricted by the necessary measures taken to limit the infection by preventing men from moving round from one colliery to another, and the men also suffered pecuniarily and not a little physically from the disease. The "Kur" was an unpleasant ordeal, and several hot discussions took place in the Imperial parliament between the men's representatives on the social democratic side of the house, and the government benches, with regard to the methods of the doctors and the Knappschafts-Verein. The government was fortunate in being able to avail itself of the organization of the Knappschafts-Verein, on whom, indeed, the bulk of the work fell. The cost of each single cure averaged about 80 marks, and the Knappschafts expended something like three millions of marks. But how effective the measures were may be judged from the fact that the number of worm-carriers has been reduced from 18,000 at the end of 1903 to 2,500 at the beginning of 1905, and it was hoped by the end of 1905 to have reduced the number to a negligible figure. What the actual monetary loss due to the epidemic amounts to, it is impossible to say, but when the loss in output of coal and in wages is added to the amount spent on hospitals, relief funds, medical equipment and sanitary arrangements, the total must necessarily be a very large one. The sum of three millions marks mentioned as having been spent by the Knappschaft does not include the private outlay of the coal companies, which in the case of some of the larger concerns has exceeded a quarter of a million of marks.

Belgium.—Cases of ankylostomiasis were recorded in 1884, and in 1885 several men were found to be infected who had worked in the St. Gothard tunnel. From 1884 to 1895, ninety-two cases were treated in the Liege hospital. More cases becoming known, steps were taken in 1898 by the president of the medical commission at Liege to determine the extent of the infection by a microscopical investigation, to decide on preventative measures, and to endeavour to educate the workpeople by means of lectures and literature. The commission immediately ran up against the fact that it had no authority to demand assistance in its work, or to ask for samples of dejecta for microscopical examination, and in most cares no facilities were extended to it either by the coal owners or the workpeople. The commission then issued literature warning the miners against the grave results that followed unsanitary habits underground, and requested that the men should not deposit their excretions in the mines, but both its warning and requests were ignored. In spite of this lack of encouragement, however, the commission as able to examine 15 per cent to 20 per cent of the underground workmen at 72 collieries. Of these collieries 49 were found to be infected and 23 immune. In some of the mines the infection was very severe, going as high as 75 per cent of the underground force. The Belgian government has taken practically no action, being afraid of the opposition of the miners and their socialistic leaders. An attempt to introduce closets underground had to be abandoned in view of the determined resistance of the miners. The subject of ankylostomiasis was discussed at great length by the International congress of hygiene, which met at Brussels in 1903, and was attended by the most eminent medical authorities. Resolutions were adopted reommending various compulsory measures, but in view of the apathy of the mine owners and the ignorant opposition of the miners. little has been done in this direction, a state of affairs in marked contrast to the strong action of the responsible authorities in the neighboring coal field of Westphalia.

France.—In the French coalfields the disease has not assumed the aggravated form that it has taken in Westphalia and the Liège Basin, but it has probably been existent in a mild form for a long time. The peculiar anemia which manifested itself in 1802 at the Anzin mines is described in a monograph by Manouvriez, and there can be very little doubt from the exact correspondence of the symptoms that this anemia was due to ankylostomiasis The rapid extension of the disease in the neighbouring countries alarmed the French authorities, and in 1902 an official enquiry was instituted under the direction of Dr. Calmette. The work was divided into two sections—the first comprising the coalfields of the north and Bas-de-Calais, and the second the coalfields in the Loire Basin. At the beginning of 1905 sixty mines had been examined in the first-named district, at thirty-two of which infected men were found. The proportion of worm-carriers was 1.8 %, 10 % being exceeded in three mines only. The results of the enquiry in the Basin of the Loire are not as yet published, but the infection is more general than in the first district, the mines of which are comparatively cold and dry, and is said to be about 5 %. The labors of the two commissions have met with ready assistance from the coal-operators, and it is not probable the infection will be allowed to spread any further: the authorities being fully alive to the gravity of the situation.

Great Britain.—Since 1893 repeated cases of anemia have occurred among the miners at the Dolcoath tin mine, Cornwall, increasing in number from one case in 1893 to twenty-nine cases in 1897. The Dolcoath mine is the most important in Cornwall; the workings are very extensive, the lowest level being at a depth of 470 fathoms. The illness among the miners was at first attributed to bad ventilation, as were the cases at Anzin in France before referred to, but after an investigation in

1902, Dr. Haldane came to the conclusion that the mine was infected with ankylostome ova. Acting on this he treated his first patient with thymol and relieved him of 260 ankylostomes. Many of the sick men suffered from itching of various parts of the skin "with urticaria-like, or pustular eruptions," called by the miners "bunches." The principal focus of the infection was the engine shaft. This shaft was used as an upcast, and in consequence was very moist and warm, the temperature being about 79 degrees Fahr. The manager, Mr. Thomas, was led to associate the prevalence of "bunches" with the pollution of the mine by excrement, and he took steps to remedy this by providing privies on the surface, and warning his men against pollution of the workings. He also improved the ventilation of the engine shaft and considerably lowered the temperature. Since that time the number of cases of anemia has considerably decreased, and at the time of Dr. Haldane's visit the epidemic was considerably abated.

The migratory habits of the Cornish miner are well known, and there is little doubt that the disease was introduced by men who had lived in tropical countries, and it is very probable the disease was introduced from South Africa or some part of South America. Steps have been taken to educate the English miners on the dangers arising from promiscuous defecation underground, and popular lectures have been given throughout the mining districts, illustrated by lantern slides of the worms in different stages. In many collieries steps have been taken to provide underground closet accommodation, and to improve the surface arrangements in this repect. A joint meeting of representatives of the coal owners and the miners' unions was called by the home office authorities to consider whether any compulsory sanitary regulations were necessary, and it was concluded that at present no measures of this character were needed, but it is not unlikely that compulsory regulations with reference to the provision of underground closet accommodation may be enforced in mines having a temperature exceeding 70 degrees Fahr.

Conclusions.—From the foregoing notes it will be seen that ankylostomiasis is a dirt disease, and has its genesis in uncleanly and unsanitary conditions. Dr. Bruns, a German bacteriologist, who took a prominent part in the Westphalian anti-worm campaign, is very insistent, in his writings on this subject, on what he calls the "disposition" of a mine to receive infection. By "disposition," he designates a combination of natural conditions favourable to the reception and dissemination of infection. Many mines possess this receptivity to such a marked extent as to be practically artificial culture grounds, in every way adapted to the propogation of the parasite. The points of infection are multiplied indefinitely, and the resultant disease among those who work amidst such conditions will attain to a virulence and to proportions that are probably impossible under natural outdoor tropical conditions. In mines of this character the course to be pursued is very obvious.

So far as the writer is acquainted with Nova Scotian coal mines this disposition is not present in any marked degree. In the Cape Breton coalfield the two conditions of heat and moisture do not exist together in the same mine. The mines are damp, as is expected from their comparative shallowness, but they are cool and well ventilated. Where the seams are worked at a greater depth the workings are warmer, but they are so dry as to be dusty. Another feature that may probably have some deterrent effect is the composition of the mine waters. They contain in many instances active chemical agents, which would no doubt act adversely on recently hatched and unencysted larvæ. As the mines advance under the beds of the ocean, these conditions may of course alter. It may be noted however that in similar circumstances the saline character of the percolated water has been found to kill the young unencysted larvæ. Again, the system of coal extraction practised in Cape Breton and the thickness of the seams, combined with their low angle of dip, are features less favourable to the spread of the infection than the corresponding conditions in European coal mines. In working bord-and-pillar there are probably more holes and corners where deposited excreta may rest in undisturbed innocuousness than is the case in the highly inclined seams of middle Europe, where the clothes and the hands of the workmen become contaminated in climing ladders and in descending chutes. In longwall work the goaf is obviously a convenient and harmless place for purpose of defecation. On the whole, therefore, natural conditions as they at present exist in Cape Breton would appear to ensure a comparative immunity from the incursions of the parasite. But, on the other hand, medical authorities have not yet fully determined what constitutes "disposition," and within what limits of temperature it is possible to promise immunity. There may be detached places in an otherwise immune mine where the conditions would favor the reception of infection. Further, and most important when considered in the light of Euopean experiences, there is a very large foreign element in the Nova Scotian coal mines, recruited in many instances from portions of the old world where the disease is known to be widespread. Many of these men are undoubtedly "worm-carriers" a state not incompatible with apparent robustness, and only to be ascertained by microscopical examination of the dejecta, and as one German medical man pertinently remarks: "a single worm-carrier working in a mine possessing the disposition to infection is sufficient to infect the whole of the mine." That it is the contaminated condition of the underground workings that give rise to ankylostomiasis as a miner's disease is evidenced by the fact that in only two recorded cases has ankylostome infection been discovered among the wives and families of the miners in the European coalfields. In the two cases mentioned the infection was caught through contact with contaminated matter. One case was that of a boy whose duty it was to clean his father's dirty pit boots, and the other was also a boy, who had been in the habit of eating the remains of his father's pit lunch.

While, therefore, there does not seem to be the remotest possibility of any need for such drastic and expensive preventative measures as necessity has demanded in the mining centres of Europe, yet a plea for at least decent sanitary conditions is quite justifiable. The individual colliery manager is the best judge of whether his mine possesses any "disposition" to infection and he can act accordingly; especially can he endeavor to prevent the promiscuous deposition of fæcal matter in hot moist situations in the mine, or in places where it is likely to be disturbed and carried along by the drafts of the mine. Any statements of an alarmist nature are most strongly to be deprecated, but the whole subject is worthy of the attention of the mining engineers and colliery doctors in the Nova Scotian coalfields, both from a sanitary and an economic point of view.

Salt: its history, occurrence and manufacture.

BY A. A. HAYWARD.

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Early history of salt.—Sodium chloride, halite or common salt, is found in nature as a mineral crystallized in cubes. Its color is transparent, but tinged with yellow, red, brown or green when impure, and when chemically pure it consists of chlorine 60.41%, sodium 39.59. It has a wide distribution on the earth, either in the form of rock salt or in solution in sea-water or brine. There seems to be few countries where it does not occur, and where it is not manufactured either from rock salt in place, sea-water or brine.

The value of salt seems to have been fully recognized at a very early period in the history of man. Salt, it is said, appears in the Sacred Volume as the emblem of eternity, reconciliation and wisdom. Numa, among the Etruscans, and Pythagoras, among the Greeks, repeated the precept of Moses: "Do not speak of Diety without fire, nor sacrifice without salt." Pythagoras calls it a substance dear to the gods; Homer designates it "devine," while Plutarch says it symbolises the soul. With the Arabs it still remains the emblem of hospitality. In Abyssinia it emphasies frendship. It figures largely in eastern story, while the secret and strange yearning mankind has for salt has not been diminished with time, nor annihilated by civilization. It is organized in the solid and dissolved in fluids and creeps into every part of the human frame and plays a part in all the complicated processes of life, without which the machine would be arrested in its operation.

Origin of salt.—The great variability in geological position of salt deposits, makes it impossible to confine them to any geological formation, while their origin is considered to be either volcanic or from evaporation from sea-water or both. The theory of their igneous origin rests upon the fact that sodium chloride and hydrochloric acid are produced by volcanic action. But the fact that layers of bitumen and organic remains are found in rock-salt deposits, would seem to render volcanic origin intenable. Recent discoveries, however, in the Texas oil-fields, of salt chimneys occurring in igneous fissures certainly afford evidence for serious consideration and investigation.

Thorpe, in his *Dictionery of Applied Chemistry*, says, salt is rarely found filling cavities or dykes after the manner of volcanic rocks, but is found in layers of various thickness covering very considerable area.

These immense beds most probably owe their origin to the evaporation of inland seas which have been cut off by slow upheaval of the land or by the accumulation of a bar or bank of sand. The sun was sufficient to evaporate as much water as was supplied by sea or by river; the part so separated became gradually richer in dissolved salts.

The upper layers, when concentrated by the sun, became heavier and sank to the bottom, while the more dilute parts rose to the surface. By degrees the lower portion of the water became so rich in mineral constituents it could no longer retain them in solution. They began to separate in the order of their solubility, the least soluble salt was the first to deposit, the other salts following in the order of their solubility. The calcium sulphate would be amcng the first materials to deposit in the form of gypsum. As the degrees of concentration continued, the sodium chloride would begin to deposit on the bottom of the basin in a solid compact mass.

In cases where connection with the sea was maintained, or when rivers continued to send in their waters, it is obvious there would be a deposit of salt accompanying the more soluble substances. The calcuim sulphate precipitated from the sea-water would, in falling, pass through rich mother-liquors crystalizing as an anhydrite. The process of deposition and crystalization was in all probability subject to various disturbances, such as changes of season, when the sun's power would be lessened, and new and excessive influxes of sea and river water.

The presence of layers of clay, sandstone and marl, varying in thickness, affords abundant evidence of such changed conditions, and that during such periods little or no salt was deposited, while during these naturally changed conditions, much, if not all, of the rich mother-liquors were diluted and so remained until recurring favorable conditions were again established, when the process once more went on. The thickness of the deposits would largely depend upon the length of favorable conditions for crystalization and deposition.

Gobel found at the bottom of Lake Elton a salt deposit 12 feet thick, consisting of 100 annual layers, which increased in hardness from the top downwards while the lake was filled with a staturated brine caused by the annual influx of seawater through long periods.

Probably one of the most interesting examples of deposition of salt is to be found in a bay east of the Caspian Sea, which is cut-off from the Caspian by a bar through which runs a small channel, through which water exhausted from the bay by intense evaporation is replenished from the Caspian Sea, thus causing a continued separation of salt estimated at 400,000 tons per annum.

In the regions where gypsum deposits occur, beds of salt are not infrequently found interstratified with the gypsum-bearing series. The association of gypsum and rock salt is due to the fact that both have a similar organ, the general opinion being that both were formed by concentration from sea-water.

Frederick Merrill says, Whatever be the occurrence of salt springs of natural brines, it cannot be doubted their contents of salt are derived from the leaching of salt in a solid state. Wherever salt springs abound there is a probability of rock salt being present in the underlying strata. It is found interstratified with clay, shale and gypsum in large beds of great extent, and its distribution is world-wide.

H. Gredner, says:—"Beds of rock salt which occur in the earths could have been produced by direct separation from sea-water or from waters of inland seas in which chloride of sodium was the principle substance held in solution." And after fully describing the various favourable and unfavourable conditions for crystalization and deposition, he continues: "Consequently beds of rock salt very commonly rest upon beds of gypsum or anhydrite, so that layers of gypsum or anhydrite appear below the beds of salt corresponding to the beginnings of the process of evaporation interrupted from time to time. Therefore deposits of gypsum over rock salt always occur in consequence of a new influx of sea-water. And if layers of gypsum and anhydrite occur alone and are not accompanied by layers of salt, either the evaporation has not advanced to the point of saturation, or the rock-salt has been re-dissolved by a new influx of water."

Some of the principle occurrences of salt.—The occurrence of salt deposits being so general, makes it unnecessary to mention more than a few of the more important ones.

At Parajd, in Transylvania, a mass of rock salt exists which has a maximum of 7550 feet in length, 5576 feet in width and 590 feet in depth, and is estimated to contain 10,595 million cubic feet. In the Carpathian Mountains beds of rock salt, gypsum and anhydrite occur interstratified. At Sperenberg, Germany, a deposit exists which has been pierced to a depth of 4000 feet, while the bottom of the bed has not yet been reached.

In France brine springs occur in several places, and in the eastern part, salt occurs in thin layers alternating with beds of saliferous clays. In Savoy at an elevation of 7200 feet above the sea, in a region of perpetual snow, a mass of gypsum occurs inbedded with chloride of sodium, which becomes light and porous when the salt has been removed by water.

In Switzerland extensive beds of rock-salt, accociated with gypsum, occur in the upper marls of the Trias.

Near Cordona, in the province of Catalonia, Spain, occur large deposits, the town of Cardona itself being located on what is termed a mountain of rock-salt; while in other localities extensive deposits occur in irregular masses in the marls and sandstones which themselves are more or less impregnated with salt. At Ebro a bed of salt occurs having a thickness of five feet, interstratified between sandstone and gypsum. Near Pora another bed is said to show indications of volcanic origin, the salt being associated with pumice stone.

Very extensive salt deposits occur in north Germany, also in Prussia, while the great deposits of rock salt in Austria are too well known to require description. The most interesting features of these deposits, however, are the numerous impressions of vegetable remains.

Large deposits of salt likewise occur in Russia in the kingdom of Perm, east of the Ural Mountains. These deposits furnish the larger portion of the salt consumed in that part of the Russian Empire.

Probably the largest deposit of rock salt known to the world is to be found at Bahadue Kliel, Judia, where it forms high and detached hills of pure salt.

In England, large deposits of salt occur in Cheshire, Worcestershire, and other localities, the accompanying formations being red sandstone and marls. It is from these beds much of the salt of export is manufactured.

The earliest recorded date that has come down to us of the manufacture and sale of salt in England from natural brine springs, seems to be about the year 64 B. C. when it was manufactured at Droitwich. At this period it seems to have been considered a valuable product and subject to taxation. This tribute or tax was continued during the occupation of England by the Romans, the soldiers at one time being compelled to accept salt as part of their pay. After the Roman evacuation these springs were continued to be worked by the lords of the soil and the king, to whom they paid a tax or royalty. The product must have been considered a valuable commodity, the market price being £31 per ton, £30 being a royalty.

During the reign of Henry VI there were in Wautwich 216 salt houses. In the year 1245, Henry III, while at war with the Welsh, caused the salt houses of Cheshire to be destroyed in order to cut off the supply of salt to the enemy; and during the reign of Elizabeth there were in Cheshire alone something over 200 salt works of six pans each, all making salt from natural brine.

During the year 1670, John Jackson, in searching in behalf of the lord of the soil, William of Marburg, brought up natural salt. This was the first discovery of salt in England. Thus it appears that salt continued to be made in England for 1700 years from brine springs, none of which exceeded 9° in density. Explorations made to greater depths show the strata to be composed ot thin beds of salt and marls. The strata through this salt region seems to be, in descending order, marl, red and blue clay, layers of indurated clay, gypsum and layers of salt.

While we have been considering a few of the many occurrences of rock-salt deposits in foreign countries, those found in the United States and Canada, are fully as extensive and of as large a commercial value, while their geological occurrences are as varied and interesting.

Early history of salt in the United States and Canada.—The bulk of salt manufactured in America is obtained either from natural or artificial brines, the amount of salt contained in solution varying with the depth and location. The latter brine is obtained from bore-holes which have been put down in or through beds of rock-salt, into which fresh water is forced and allowed to remain until the water has taken up salt in solution to a point of saturation, or 100° salinometer.

In the United States and Canada, salt and brine springs were known to exist at a very early date, and to-day very few states and provinces are without salt; either in place or solution.

About the middle of the seventh century the Jesuit missionaries, during their journeys among the Indians in what is now known as the state of New York, learned of certain springs which were regarded by the aborigines with suspicion, and were said by them to be possessed of demons. In the relations of the Jesuit fathers, we find the earliest recorded details of these salts or brine springs. The people of the state of New York were, in all probability, the first to investigate these saline springs, and the first to make commercial salt. The most important springs were located at Syracuse, Onondago county.

The discovery of brine springs by the Jesuits led to the manufacture of salt by the Indians and traders, so that in 1770 salt was in common use among the Deleware Indians, and the traders brought it to Albany along with their furs.

The systematic manufacture of salt by white men was not begun until the year 1788, when it was made at what is now Syracuse. In 1789 Nathan Loomis began the manufacture of salt with a number of kettles, and during the winters of 1789-90 made from 500 to 600 bushels, which afterwards sold for $1 per bushel. Jeremiah Gould was the first to make salt with kettles placed on arches, and others continued to make salt from brine in their own primitive fashion until the year 1797, when the state legislature, recognizing the importance of the industry, passed its first laws regulating the manufacture of salt from the brine springs in Onandago county, and William Stephens was appointed the first superintendent.

Improvements were continued from year to year. Pumps were installed, while horse and water power was used as a motive power to operate these pumps, and the business as a whole took on a more definite form. During the year 1823, 2,000,000 bushels of salt were made from the brine springs of Cayaga county alone.

About the year 1820, or thirty-one years after the birth of this industry, and 180 years after the recognition of the commercial value of the brine springs, those interested and who had some geological knowledge of the immediate locality, began to seriously consider the source of these brines. During the same year the state legislature authorized Benejah Byington to bore for rock salt. His efforts, however, were unsuccessful, and salt continued to be made from natural brine. In 1838, an appropriation was made for the sinking of a shaft 600 feet. This attempt also failed to locate rock-salt in place. The state geologists were, however, confident the Onondago springs were supplied by the leaching of beds or layers of rock salt somewhere in the underlying strata, and further efforts were made to locate these beds, but without success, and it remained for the inferred existence of salt to be accidently demonstrated by a bore-hole put down for oil in the western part of the state. This was the first salt discovered in America.

Lewis C. Beck in his report on the mineralogy of New York state for 1842, in giving a list of the saline springs in the state from which salt was made, says some of the brines in Fulton county carried salt as low as 4 degrees; while in Mayne county some of the springs contained brine as high as nine degrees.

Michigan, which ranks second as a salt-producing state, was the second to recognize the value of its saline springs. And while the larger part of the commercial salt now being manufactured is derived from salt deposits, much, however, is still manufactured from natural brines pumped from the lower strata and of various degrees of density, that of the Saginaw

Valley having a density ranging from 78 to 90 degrees, depending entirely upon the quantity pumped. At an early date it was known the Indians were supplying themselves with salt obtained from brine springs, and numerous reservations of land supposed to contain salt springs were made by the Federal government. Before a state organization was affected, attempts were made to manufacure salt from brine obtained from these springs, and so valuable were these lands considered, that by the act of admission of the state into the union in 1837, the state authorities were permitted to select twenty-two sections as salt springs lands. Mr. Douglas Houghton was appointed state geologist at the first meeting of the legislature, and in his report to the legislature in 1838 says he regards it as important that the spring lands be selected for state purposes at an early date.

Although public attention was directed to these salt springs, and their development for a time vigorously prosecuted, success was not complete, and the death of Dr. Houghton in a measure discouraged further development for a time. The experience gained, however, was of value, and further researches were made fully demonstrating the commercial possibilities of these saline waters.

The people of the Saginaw Valley were the first to successfully demonstrate their commercial value. Encouraged by the information furnished by the geological survey, borings were made in other localities and groups of rocks much older and lower were pierced, which demonstrated the density and extent of these saline deposits and rendered them an immense wealth to the state.

Although salt has continued to be made from natural brine having a density of about 80 degrees, none of the many wells have ever encountered rock salt, the nearest known deposits being distant 140 miles, and it is from this deposit these brines are thought to derive their saliferous material.

The capacity of salt wells vary in localities, while the size of the bore-hole and the porosity of the rock have much to do with increasing or decreasing the amount of brine to be obtained. From 12 to 20 gallons a minute is said to be the average capacity of a good brine well, At East Tewas the wells are 3½ inches in diameter, and fill a cistern 20x30x6 feet in twelve hours.

At present salt is manufactured from salt or brine found in New York, Pennslyvania, Maryland, Virginia, Tennessee, Kentucky, Texas, Ohio, Kansas, Utah, Nevada, California, and Michigan; also in several localities in Upper Canada. The states of New York and Michigan, during the year 1902, furnished over two-thirds of the 23,849,221 barrels manufactured in the United States, and which had a net value of $5,668,636.

Manufacture of salt.—The various methods employed in the manufacturing of salt, either from natural or artificial brines, are as fully interesting and varied as its occurrences in nature, while the cost of production depends largely upon the local conditions, and the methods employed.

The salt of commerce is derived from the evaporation of sea-water, natural or artificial brines, and directly from the crushing and grinding of rock-salt. That derived from sea-water is made by two opposite methods, the one by solar evaporation in pits, the other by the aid of frost.

In China, there are numerous wells from which brine is extracted in bamboo pipes and then evaporated by means of natural gas obtained from the adjoining petroleum wells. In India large quantities are made by solor evaporation. Along the Coromandel coast numerous plants are maintained for the manufacture of salt by the evaporation of sea-water.

At Madras and Orissa alone there are over sixty factories, while in Portugal and certain countries along the shore of the Mediterranean, sea-water is extensively used as a source of salt, and is evaporated by the sun's heat in what are called "salt gardens." These are large shallow basins excavated along the seashore, consisting primarily of a large reservoir several feet in depth, into which the sea-water is drawn at high tide during the month of March. In this pit the water is allowed to stand sufficiently long to deposit all matter in suspension before it is run off into evaporating pits or tanks. These crystalizing pits are very shallow basins, through which the saline water is made to flow in a zig-zag course. They usually cover several acres, and are well exposed to the action of the winds and sun. From the large tanks the crystalizing pans or gardens are fed, the salt being raked out when a sufficient amount has accumulated, and, as evaporation takes place, more water is allowed to flow into the pans from the settling tanks. The mother-liquor is allowed to flow back into the sea, unless retained for the manufacturers of bromine.

Another process for the making of salt from sea-water, and used in cold countries, is a reversed one. The saltwater is first allowed to freeze; the ice which forms, consisting of nearly pure water, is then removed. By repeating this operation several times a mother-liquor is obtained which is sufficiently strong to boil down. But salt thus made is far from pure, as it contains only about 75 per cent. of sodium chloride.

In making commercial salt from either natural or artificial brine by the solar system as employed in the United States, the brine is first pumped from the wells into what are known as the deep rooms. The brine is there allowed to remain until it has deposited much of its impurities, when it is drawn into a second tank and again allowed to remain until it has reached a point of saturation, or 100 degrees salinometer at which point small crystals begin to appear. The brine is then called by the operators "pickle." It is then run into shallow wooden vats called salt rooms. It is in these rooms that rapid evaporation takes place, and as it continues, the crystals formed, increase in size, and sink to the bottom. As the pickle is diminished by evaportion, new pickle is allowed to flow in to replace that evaporated, and so the process continues until a sufficient amount of salt has accumulated, when it is removed to the dry-houses. These salt rooms are provided with movable covers which are placed on wooden wheels and are run over the salt rooms during wet weather. The salt made at Syracuse is largely manufactured by this process, two crops or clean-ups being secured each season.

Several other processes are employed, both in the United States and Canada, the two principle ones however, are the grainer and vacuum-pan. While the former costs less to install, the latter is said to produce the larger amount of salt per ton of fuel consumed.

By the grainer system a larger varied of salt, can be produced, while the vacuum-pan process is confined practically to one grade.

The *grainer system* consists in passing live steam through a set of iron pipes submerged in long shallow wooden vats, resting on strong wooden frames. These vats are usually 12 to 16 feet wide and from 100 to 150 feet in length, the sides being about two feet in height. They are provided with 4 or 6 steam pipes which extend the full length of the grainer and have a diameter of from 4 to 5 inches. These pipes are suspended some distance from the bottom of the tank ; which is provided with an automatic rake, which passes underneath the pipes, to remove the salt as it is deposited on the bottom of the grainer.

As the brine comes from the wells it is received in large wooden vats, and after settling is drawn into a second large tank, having a length equal to the grainer, but six feet in depth. These tanks are also provided with steam pipes of large diameter. As the temperature in the grainers is maintained at nearly the boiling point, it is necessary that the brine entering them should not be very much below the same temperature, and as much of the steam supplied to the grainers is not condensed, it is passed from the grainers into the settling tank, together with the addition of some live steam.

To produce the best results, the pickle in the grainers must not become overcharged with calcium and magnesium chlorides. This can only be overcome by removing from time to time the inferior pickle. As this pickle still contains a percentage of salt it is further treated in what are known as divided grainers.

The coarseness of the grains of salt made by this process depends entirely upon the rapidity of evaporation,—the lower the temperature or the slower the evaporation the larger the grain. The salt after being removed from the grainers is allowed to dry for ten days when it is ready for market.

The *vacuum-pan process* consists of evaporating brine by steam, under a reduction of atmospheric pressure. The plant consists of a large vertical cylinder of iron in which a vacuum is produced. By reducing the atmospheric pressure the boiling point of the brine is lowered and a quicker crystallization is produced and consequently a fine grain salt is the result. In this iron cylinder there is a large number of copper tubes, each end being connected with an iron tube or head at right angles to the copper tubes, through which live steam from the outside is supplied. These copper tubes are surrounded by the brine, and the salt as it crystalizes falls into falls into a large iron pipe at the bottom of the pan where it can be seen through a peep-hole. When a sufficient amount has accumulated, a valve is closed above the salt and against the atmospheric pressure. The salt is then removed and dried ready for the market.

It is rather difficult to determine the exact cost of production by either of the processes, as the managers vary the process to suit local conditions and so gain points of advantage; consequently they are not disposed to disclose manufacturing secrets and costs of production.

It would seem from investigation with brine of 100 degrees, that the grainer system produces about one-and-a-half tons of salt with a consumption of 2,000 pounds of culm coal, while the advocates of the pan system claim about two tons from the same consumption. In support of this I have ascertained that some of the firms at Marine City are selling bulk salt, manufactured by the pan system, at $2 00 per ton, and making quite a satisfactory profit. In order to produce one ton of salt from brine of 100 degrees, it is necessary to evaporate 21½ gallons of water per bushel of salt recovered, or 779 gallons of brine for a recovery of 2,000 pounds of salt.

Brines in Nova Scotia.—With the richest brines yet found in Nova Scotia, it would be necessary to evaporate 28½ gallons of brine for each bushel of salt obtained, or about 1,000 gallons for each ton of salt recovered—an excess of about 200 gallons to be evaporated.

The valuable evidence furnished by the brine springs of this province was fully recognized by Prof. Henry How in a paper read by him before the Nova Scotia Institute of Science on March 6th, 1865.* In this paper he speaks of several saline springs in various localities from which the salt was made, and refers to a company which made salt from a spring in Pictou county as early as 1845. He also states that these brines carry a high percentage of bromine, and that some of the gypsum he examined near Windsor, Hants county, contained rock-salt. Twelve miles from Baddeck a strong brine spring exists, which yielded one bushel of salt from 100 gallons of water. In conclusion he says, from what we see of the number and distribution of the brine springs of this province, the manufacture of salt may be expected to become a considerable branch of industry, as the composition of the brine issuing from the lower carboniferous rocks is favourable to its manufacture.

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* On some brine springs of Nova Scotia. By Henry How, D. C. L., *Trans. N. S. Inst. Sc.*, vol. 1, pt. 3, p. 75.

Again, in 1867, he refers to the subject and says, that although no rock-salt of any importance has yet been found with the gypsum, the brines of the gypsiferous districts have furnished excellent salt, as at River Philip and Springhill, and that a company is making salt at Antigonish.

Dawson, in his *Geology of Nova Scotia*, says, the saline springs found in various localities occur in the lower carboniferous rocks, and he points to the association of their saliferous matter with the gypsum and marls He further refers to Mr. Deacon, of Halifax, as having put down a bore-hole at Antigonish, 154 feet, the rocks penetrated being gypsum and marls, with bands of limestone, while the brines encountered were copious and rich.

Almost invariably, when salt occurs, there is present somewhere in the geological structure deposits of gypsum or anhydrite, or both. It is also apparent that gypsum or anhydrite, or both, may be present without deposits of salt, but impossible to have the latter without the former. If, as it would seem, it is necessary to have deposits of gypsum if we are to have salt, do not the immense deposits, which are known to exist in many localities throughout the province of Nova Scotia, furnish some valuable indications of the existence of rock-salt, and is not the evidence very much strengthened by the large number of brine springs which are known to exist wherever gypsum deposits are found ?

During the summer of 1904 a local company, prospecting for oil at Cheverie, Hants County, put down two bore-holes a distance of about 2000 feet each. These holes passed through large deposits of gypsum, anhydrite, marls and sandstone, and while they encountered brines of different densities in their descent, those at the bottom had a density of 76 degrees. And when we compare the density of these brines with those found flowing at the surface, their increasing density must strongly point to deposits of salt of more or less extent somewhere in the underlying strata, and what has occurred in this locality should be duplicated in many other sections.

The brine springs themselves are of no particular commercial value, as their density rarely exceeds that of sea-water, but they are a valuable link in the chain of evidence, inasmuch as they point strongly to the existence of salt deposits yet to be discovered in many localities throughout this province. That these springs have continued to flow for ages, undiminished in either volume or saliferous material certainly adds materially to the already existing evidence.

The Maritime Provinces as a market.— Most of the salt consumed in the Maritime Provinces is imported from Liverpool, Spain, Portugal, and Italy, and a small amount from the West Indies, as will be shewn by the following tables, and had a value of $140,676: while Montreal alone imported $101,454.

During the year 1904 there was imported into Canada salt free of duty which had a value of	$338,082.00
Dutiable salt, or salt on which duty was collected	74,186.00
Making a total of	$412,268.00
Of this amount Great Britain and her dependencies supplied	$289,749.00

The balance came from foreign countries as follows:

Australia	11.00
British West Indies	11,929.00
Newfoundland	335.00
Cape Verde Islands	920.00
Italy	10,751.00
Portugal	1,807.00
St. Pierre	476.00
Spain	10,828.00
United States	6,307.00

Importation of salt by ports.

Halifax, N. S.	$ 42.196.00
Hamilton, Ont.	1,189.00
Montreal, Que.	101,454.00
Ottawa, Ont	1,392.00
Quebec, Que.	36,068 00
St. John, N. B.	62,409.00
Toronto, Ont	2,862.00
Vancouver, B. C.	12,706.00
Victoria, B. C.	6,005.00
Winnipeg, Man.	388.00

During the year 1903, Canada manufactured 53,537 tons of salt of various grades, valued at $334,008; and during the same period exported Canadian-made salt having a value of $2.724. There were exported during the same year 253,668 bushels of foreign salt. While a large amount of the salt imported into Canada is consumed for domestic purposes, the bulk is used in the fisheries, and is purchased by the ton of 2,240 pounds, in cargo lots.

The quotations on salt for the year 1905, as furnished by a large foreign exporting house in England, are as follows:

Ordinary, Liverpool, 12 bags per ton of 2240 lbs.	$ 5.25
Fishing salt	6.12
Factory filled, 200 pound bags	8.75
" " 50 " "	10.25
Liverpool, in bulk	4.25
Solar salt	3.43

C. I. F. Halifax cargo lots.

It will be observed the lowest price quoted ($3.43) is for a quality and kind which forms the bulk of salt consumed in the Maritime Provinces. The price quoted at Halifax during the season of 1905 for this grade of salt ranged from $1.20 to $1.35 per hogshead, or from $5.40 to $6.00 per ton of 2000 pounds.

Under favorable conditions, salt should be manufactured and distributed to points of consumptions in the Maritime Provinces and Newfoundland at a cost which should not exceed $2.75 per ton.

Conclusions.— Nova Scotia, together with the other Maritime Provinces and Newfoundland, are the salt consuming sections of Canada. and certainly furnish an ideal market for fishing-salt; while the demand for other grades such as grocery, farm, beef and table salt, and on which a duty is collected, is fully as large per capita as any of the other sections of Canada.

With all the natural conditions existing in Nova Scotia, such as moderately cheap fuel, water freights to points of consumption, large and increasing markets, satisfactory margin for profits above cost of production, and a freight rate of $1.75 to $2.00 per ton against foreign-made salt, should not such favourable existing conditions be sufficient to stimulate a further investigation of our saliferous deposits?

The object of this paper is to draw the attention of our provincial people to another probable source of wealth within our borders, and in doing so I have been obliged to draw from the compiled information of others. In this connection I wish to make grateful acknowledgements to Frederick J. H. Merrill, H. Credner and Dr. F. E. Englehardt.

PROCEEDINGS

ANNUAL MEETING, 22nd & 23rd MARCH, 1906.

The annual meeting of the Mining Society of Nova Scotia was held at the rooms of the Board of Trade, Halifax, on the 22nd and 23rd March, 1906, with the president, A. A. Hayward in the chair.

The following gentlemen were present: Dr. Henry S. Poole, Richard H. Brown, Francis H. Mason, Fred. P. Ronnan, George W. Stuart, Prof. J. E. Woodman, Hon. S. H. Holmes, Prof. Frederic H. Sexton, W. C. Milner, J. A Johnson, James Baird, J. L. Greenough, W. A. Brennan, Joseph H. Austen, W. H. Sterns, Harry Piers, M. R. Morrow, G. L Burrit, Harry M. Wylde, W. H. McRoberts, George E. Francklyn, Prof. R. H. Richards, A. M. Bell, Philip A. Freeman and Alexander McKay.

The minutes of the previous meeting were read and approved. The treasurer's statement was presented and adopted.

Election of Members.

The following were elected members: Thomas J. Brown, Sydney Mines; John Fellows, Stellarton; John B. Forster, Oldham; W. L. Ogle, Halifax; James Crease, Mount Uniacke; A. L. McCallum, chemist Dominion Iron and Steel Company, Sydney, (since of Halifax); H. McKier Weir, Torbrook; H. W. McInnes, Halifax; and William J Hopgood, Halifax.

President's Address.

A. A. Hayward.—Instead of preparing an address of the usual character, rehearsing at length what the society has accomplished and offering apologies for what may have been left undone, repeating history perfectly familiar to all, particularly those who have taken an active interest in the affairs of the society, I have preferred to change conventional methods, and to give an address on a commercial subject, claiming no precedent, as the policy is one that is followed by a number of societies of like nature. By following these lines we shall at least be looking forward rather than backward. I have selected as a subject halite or common salt. But before taking up that subject I would like to refer to a matter directly connected with the society.

In looking over the past it seems to me our experience somewhat resembles that of the children of Israel, who wandered about the wilderness for many years before they secured a home in the promised land. So it has been with this society: it has wandered about from place to place, holding its meetings wherever any kindly disposed person might offer a sheltering roof. To-day it would seem as though we had reached the promised land, and I trust we will settle down in our new home to enjoy any benefits that we may have gained from past experience. Through the generosity of the Board of Trade, we have been granted the privilege of using the room we now occupy for our annual and semi-annual meetings, and I trust we shall show our appreciation by our cooperation in any movement that shall tend to strengthen and enlarge the commercial position of this city and province.

Your committee has prepared a new constitution and by-laws, which you will be called upon to adopt. I would suggest their adoption as they now stand, and any changes that the practical working thereof may show to be desirable, can be made at a future meeting.

The gold-mining committee appointed at the last annual meeting, and which reported at the last semi-annual meeting, was successful in accomplishing the object for which it was created. Mr. Thomas A. Rickard, M. E., was by them recommended to the government as the proper person to make an examination of the gold-fields of the province. Mr. Rickard's services were secured, the examination made, and a report forwarded to the government, which has decided to withhold the same until it can have further commuication with Mr. Rickard.

The society, at its last meeting, voted a scholarship to Dalhousie college for one student engaged in the mining profession. I am pleased to inform the society that various pieces of machinery for the testing of ore, including a five stamp mill, have been erected at this college and nearly completed.

During the year, the society has been called upon to record the death of two of its oldest and most valued members—Mr. B. C. Wilson, of Waverley, who for many years was actively engaged in mining and many of its branches, and Mr. Geoffrey Morrow, who, while not actively engaged in mining, was always an ardent supporter of all forward movements in the society.

It has occurred to me that there are many lines of usefulness to which we could direct our energies to greater advantage, and as members of this society it is our duty to take a stronger grasp of the many commercial possibilities that seem to present themselves on either side. Do we fully appreciate the opportunities we have to assist in the development of the natural resources of this province, and do we consider these natural resources of any commercial value? If we do, then it is our duty to develop some well matured plan that will assist in the unfolding of these possibilities, so that masters of industries may have presented to them a commercial picture worthy of their serious consideration. Let this society each year by its combined efforts try to be instrumental in creating one single new and valuable industry· Such a policy would be far reaching in its effect, and we would be assisting in the commercial prosperity of the country, and by so doing establish a right to confidence and respect. I would suggest the advisability of the society seriously considering this policy, and would ask it to appoint a committee which shall more fully consider the question and deal with it as it may think advisable, leaving to it a selection of a subject for investigation.

This year we added one new feature to our programme,—namely, that of introducing at our annual banquet, a topic for debate that shall be of interest and benefit to the people of this province. If this policy is carried out with the spirit it deserves, and the proper subjects and speakers are selected, the annual banquet should be looked forward to with much interest by the citizens of this city and province. In introducing this particular feature we have this year selected as a subject, Technical Education, and have secured as the speaker Prof. R. H. Richards, of Boston, a gentleman too well known in this part of the country to require further introduction. The subject, however, is one that should appeal to every man, woman and child in this province who understands and appreciates the natural resources of his country, and desires their furthur development.

[The President then read a paper on salt, which is reproduced elsewhere in this volume.]

Report of Gold Mining Committee.

PRESIDENT HAYWARD.—Perhaps Dr. Woodman of the gold-mining committee will explain why it is necessary to ask for our indulgence, in regard to Mr. T. A. Richard's report, and why we should be patient until we get the report from the goverment.

DR. WOODMAN.—In order that what the members of the Mining Society and the mining public generally have a right to know concerning the report of Mr. T. A. Richard, may come from an authentic source, I have prepared the following statement of the case.

The report of Mr. T. A. Rickard, when received by the government was found to lack clearness on certain points. After considering the matter at some length, the government requested certain gentlemen interested in mining in the province to confer with them. These were the members of the former committee on gold mining of this society; but, inasmuch as that committee ceased to exist at the last meeting of the society its former members were honoured by the government with the invitation merely as individuals who had a knowledge of the situation from the beginning, and they have acted throughout under that condition. To them, later, were added by request of the government, two more gentlemen who were regarded as being especially fitted to advise in the matter.

These gentlemen have conferred with the government and with Mr. Faribault; and have offered certain suggestions to the former, which are being acted upon at the present time.

It will be seen that the report must at the present time be regarded as a part of an uncompleted task; and while this condition obtains, it is manifestly improper for those who have been called in by the government to enter into any further statement, explanation or debate upon the subject.

Report of Committee on Iron Mining.

B. F. PEARSON presented the report of the committee on iron mining, which was read as follows:—

At the last meeting a committee on iron mining was elected by this society, and charged with two tasks. One of these was to place before the Dominion government, through its tariff commission, a plea for direct aid to the miner of iron in Nova Scotia, through a cash-bonus for each ton of ore of some standard quality accepted at a smelter. At the meeting of the commission in the board of trade rooms, this was urged upon its members; and, whatever the outcome may be, the committe has done all that it can in the matter. The second duty set was to approach the provincial government on the subject of having such surveys made of the iron-bearing rocks of the province as would determine, if possible, the character and extent of the iron contents. On this subject the report of the committee must be incomplete, and it has been thought best to report back to the society for further discussion and instructions.

The conditions surrounding the proposition of the society for a survey have changed materially since the instructions were given. At that time assurance was given the society, informally, at its dinner, that the government would appoint an expert for the examination of the iron deposits as it had for the gold problem.

Two requests were open for the committee to make—(1) to appoint an expert to make a preliminary examination of the iron-bearing horizons, and to report on the possibility, advisibility, time and cost of such survey as might be desired; (2) to appoint an expert directly for such survey, without preliminary investigation. It is understood and pointed out in discussion at two previous meetings, that this is a much larger problem than that of gold, from the standpoint of time and expenditure. If it were decided finally to have no survey, the first of the two methods mentioned above would involve the use of an expert's fee. If a survey were determined upon, its expense would be incurred, with or without an expert's fee for preliminary examination. Such survey, to be valuable, should be detailed and accuarate, on a large scale, and very likely accompanied by contoured topographic maps. The task would be by no means a small one.

When, therefore, the report on deep gold mining was received, and its effect upon those who read it was noted, it was at once thought to be both unwise and unfair to approach the government at that time, with a project of a similar sort, involving inevitably a larger cost. It appears to your committee that the same conditions are still operative, and that it is as unwise now as it was a short time ago, to ask the government to spend the people's money in the way indicated.

But the problem has another side. It has been repeatedly urged in meetings of this society, that for the best interests of the province there should be a geological survey inaugurated and controlled by the local government, whose duties should include the monographic problem study of economic deposits or economic districts. This survey would not duplicate work now being done by the Dominion Survey, but would begin where that has left off, and do what is most urgently needed to-day in this province—acquaint the public in detail with their mineral resources. It is surely unnecessary, at this stage, to urge or to defend the necessity of such a survey. Practically no voice has been raised against in past meetings, and many have spoken earnestly in its favor. In the minds of at least some of those who have urged government aid in special investigations of both gold and iron, the vision has stood behind these projects, of a time when the government would see the wisdom and economy of having a permanent geological survey, adequately maintained.

Without going into further debate on the subject, we would recommend that this committee be authorized to approach the local government for the installation of a provincial geological survey. We believe the time is ripe for it.

Dr. Woodman.—I have just come from the government with Mr. B. F. Pearson. We approached it with respect to the investigation of the iron ore deposits of Nova Scotia and had a favourable hearing and found it extremely anxious and willing to take hold of the problem. It thought that perhaps the government at Ottawa might enlarge its survey and cover the things we want. We desire to do the work which the Dominion geological survey in unwilling or unable to do. The local government thought that if a representative commission were to go to Ottawa, that the Dominion government would make an increased appropriation to have this work done. In that case we can have it done under a joint survey under the control of the local government and thus get all the information we desire.

The premier thought that the province could not afford to establish an independent survey under the present circumstances. He said his government will pay the expenses to Ottawa of the Commissioner of Works and Mines, B. F. Pearson, myself and any other delegate the society appoints. It has always been the policy of the Dominion geological survey, not to do detail work in any district.

F. P. Ronnan.—I am sure the society is indebted to the committee for the work it has done, and I move that the committee be continued to see that the work is completed as outlined.

H. M. Wylde seconded the motion which passed unanimously,

On motion of F. H. Mason seconded by J. Baird, Dr. H. S. Poole's name was added to the committee.

Legislation with respect to Stealing of Gold.

G. W. Stuart.—As you are aware, we employed Mr. Frank Bell to draw up an amended form of the bill on gold stealing from mines, in accordance with the suggestions made to the government. He has had considerable correspondence with different members of the government and particularly with Mr. Sinclair. He reports to me that at present the matter stands thus:—After being passed several times in its amended form by the committee on amendments of the criminal law of the house, it was concluded that the matter would have to stand over. There has been some talk of a general revision of the criminal law, when it might be taken into consideration. But Mr. Bell thinks there is very little chance of having that amendment incorporated in the criminal law of the Dominion unless it is recommended by our own provincial government. He says he is quite sure that if our provincial government should recommend to the federal government that such an amendment of the criminal law be made, there would be no question but that it would be done and done at once. Therefore, I think that it is advisable for us to pass a resolution and appoint a small committee to wait upon the Attorney-General, or the government if you think best, asking for a recommendation to the federal government that such an amendment of the act be made. I suggest that a committee be appointed for that purpose I cannot see how the government could for a moment refuse to make the recommendation because it is a matter that affects the income of the province very much; it not only affects the mining men but affects the government as well, because the latter is robbed of its royalties. There must be hundreds and thousands of dollars stolen from our mines from which the province has no return.

F. H. MASON.—I move that the former committee be re-appointed to carry out Mr. Stuart's suggestions.

F. P. RONNAN.—I second the motion.

The motion on being put was passed unanimously.

Nominating Committee.

On motion the following gentlemen were named a nominating committee to select names of officers for the ensuing year:— Messrs. Stuart, Poole, Morrow, Austen and Woodman; and on motion it was resolved that the officers for the ensuing year be appointed in compliance with the new constitution and by-laws

The meeting then adjourned until 2.30 p. m.

AFTERNOON SESSION.

Publication of Papers.

F. P. RONNAN.—There is a matter I would like to bring up in reference to the reading of papers. In the past we have followed the custom of having the papers read without prior publication. Of course it is difficult to discuss them with any previous idea of the matters in them. Would it not be advantageous to have the papers submitted to the council some few days before the meeting of the society, then the council could communicate the matters contained in them to the members and in that way the papers would be discussed intelligently. If some such plan could be devised we would then have an interesting and intelligent discussion of the various papers read.

G. W. STUART.—I entirely agree with Mr. Ronnan in regard to the publication, at least the papers should be submitted to the council previous to their being read. As Mr. Ronnan has said, you cannot at a moment's notice discuss a paper very intelligently. If something could be done to bring this about, I believe it would be an excellent thing.

DR. WOODMAN.—The question is, is it possible to get the papers beforehand? During the last few years there was only one case where we able to hear the paper before it was read. that was Mr. Libbey's paper. In an organization of which I am a member. it is required that a paper shall be submitted to to the council, or an abstract laid on the table the morning of the meeting. But that may not be possible in a small Society like this. One of the papers that was read here today was only finished at nine o'clock this morning, and another at one o'clock. If the paper could be secured early enough, it would be all right. At present I do not see how it can be done except through the persuasive power of the secretary.

W. A. BRENNAN.—I cannot understand the practicability or the possibility of having a paper or even an abstract laid before us before the meeting opens. The whole usefulness as a paper is to have its originality thrust on the meeting, and therefor the discussion which follows is purely and simply original. If someone has had time to dissect it and criticize it severely, it is hardly fair to the writer.

PRESIDENT HAYWARD.—Then there is another side to the question: the probable cost and labour entailed.

W. A. BRENNAN.—Would a paper have to be handed in a week or a month or two months beforehand, and would it then have to be printed and distributed among the members?

PRESIDENT HAYWARD.—That would be the only way in which it could be done. It certainly is a very desirable thing, but it would entail a great deal of expense and a great deal of labour on the part of somebody.

W. A. BRENNAN.—A paper of the magnitude of that of salt, which you read to-day, is deserving of a great deal of consideration, and it is quite time enough at our next meeting to discuss it.

PRESIDENT HAYWARD.—There is no possible means by which it could be done, except through the daily press. It could not go into our Transactions before the end of the year.

DR. WOODMAN.—In the American Institute of Mining Engineers, the members have the privilege of having their papers published in pamphlets. That is a method which I would advocate.

G. W. STUART.—There is something in Mr. Brennan's contention. If the publication of the papers is going to submit authors to such criticism as would intimidate them from producing papers, then possibly it would be better not to have them published beforehand. It has been, and presume will be for some time to come, a difficult matter to have as many papers as we should have. There has already been some harsh criticism on papers that have been read before the society, which I think has had the effect of intimidating members from constributing. No doubt our meetings will be very much more interesting if the papers could be discussed more intelligently.

F. P. RONNAN.—It is not so much a criticism that one would like, but an amplification of the subject. A writer may advance a theory in connection with mining, and put it forward tentatively, and by inviting the study of his paper beforehand he will probably get their co-operation, which may be of the utmost importance to the subject. I move that a committee be appointed to take the matter up and to report upon the feasibility of such a plan.

Dr. Woodman seconded the motion, which passed unanimously. The committee was then appointed, consisting of Messrs. Woodman, Piers and Ronnan.

Economic Topics for Discussion.

Dr. Woodman.—I would like to speak on the point referred to in the president's address this morning, regarding the attempt to have members undertake the gathering of data on some economic topic during the year. I think it would accomplish the acquisition of facts which are not at present obtainable.

President Hayward.—My idea was that this society should each year take up some subject and gather all the information that it is possible to obtain thereon and have it compiled. If this were carried to a conclusion it might be the means of establishing some new industry. Of course we have accomplished a great many good ends during the existence of the society, but it seems to me there is one definite thing we could take up which would be of great advantage to the province. I referred to the subject of cement, if we were to appoint a small committee dealing with that subject it could examine limestone deposits and take up the commercial aspect as well. If it then made its report in the form of a paper, that would be printed in the transactions of the society, it might come before the eyes of capitalists, which possibly would be the means of bringing about a new industry. I only used that as an illustration of what might be done I think we have the means and talent to take up almost any subject. We can pick from among our members a few men versed on any subject that would be of importance to the province—and I do not see any more effectual means of doing something which would be of value to the people of this province than to do what I have suggested. In order to inaugurate a policy of this nature, it is necessary first to select a subject for investigation. If we could make a selection today, we could also arrange for another subject to be brought up and discussed at a future meeting. At our next semi-annual meeting several subjects could be brought up and we could select which subject would be investigated. Let us take up any subject that will be a benefit to this province.

F. P. RONNAN:—All the conditions in regard to cement point to the coming year as being a cement age. The progress that has been made in the United States in that particular industry would probably astonish a great many of our members if they were familiar with it. It is certainly well that we take up a subject and study it at close range and made an attempt to apply the knowledge gained in a practical way. I move that a committee be appointed, to take up the subject of cement and the cement industry as a possible one in the province. The committee could report to the council as soon as possible, and it will be under the direction of the council.

W. A. BRENNAN:—I think there is no doubt about the advisability of such a resolution at this time. We ought to recognize the resourcefulness of the province. Nova Scotia is not altogether given to mining; and it has many features that have not so far been developed. I think the motion is a good one, and I believe it will be conducive of good work in the course of time. It does not follow that this society is altogether for the development of coal, iron, gold and silver, and everything in the shape of hard mining. This is really a cement age, there is no question about it. The demand for cement today is something phenominal. I suppose the demand has multiplied two hundred fold within the last five or six years. I second Mr. Ronnan's motion.

The motion upon being put was passed unanimously.

On motion the following gentlemen we appointed a committee to take up this question—Messrs. Sexton, Woodman and Milner.

On motion of J. H. Austen, seconded by F. Ronnan, a sum not to exceed two hundred dollars was placed to the credit of the committee to draw on as it saw fit.

W. C. Milner.—I hope that the members will not expect too much from us the first season. The field is so great that has to be gone over.

Departure of F. H. Mason.

G. W. Stuart.—I desire to refer to an honored member of this society, Mr. F. H. Mason, who is about to leave this province. He has accepted a very responsible situation in California ; and I think it is only appropriate, knowing Mr. Mason as long and as favourably as we have, that this society should refer to his departure and his great service to the province and to this society. I am sure that Mr. Mason has not only been of great service to us in his profession, but he has also endeared himself to every member of the society and every man he has come in contact with in business or in a friendly way. I beg to move the following resolution :—

"This society, while expressing pleasure at the recognition of Mr. F. H. Mason's ability and integrity which has come from the opposite side of this great continent, thus securing for him a most responsible and, we trust, lucrative position, in the golden state of the United States, yet it extremely regrets the great loss this province, and more particularly this society, will sustain by his departure, and wishes him that full measure of success in his new sphere of duties that it is believed he is entitled to.

"Therefore resolved, that the society place Mr. Mason's name upon its list of honorary members."

Dr. Poole.—I have great pleasure in seconding the motion. One of Mr. Mason's valuable points was his accuracy, and the trust that one could place in him. If anyone put samples in his hand he would get a fair and correct report, and he would be taught how to take samples to get at their value in dealing with other people. I am sure we all know with what pleasure we have met him at our meetings.

Dr. Woodman.—I may say of Mr. Mason that in a country and in an industry were petty jealousies are not infrequent, he stands without an enemy, which is something which can be said of hardly any man in any country. If it is not going beyond the bounds of professional etiquette, I may also say that in a few cases where I have seen samples sent to Mr. Mason for assay and also seen analyses of samples from the same ore-dumps, taken as checks, made by other assayers, Mr. Mason's figures were found absolutely reliable.

The motion passed unanimously.

F. H. Mason.—This resolution comes as quite a surprise to me, and I do not know how to thank the society for the kind wishes it has extended to me. In leaving the province I am sorry to part from so many of my old friends. I have enjoyed very much the friendly meetings we have had in the past, and shall always think of them with pleasure.

The Dominion Exhibion.

F. P. Ronnan.—In view of the fact that we will have a Dominion exibition here this fall, I believe it would be wise on our part if at an early date we took steps to keep the subject before the public, in order that we may have an increased mineral exhhibit.

H. Piers.—I may say that arrangements have already been made for next year's exhibition. Not many provisions can be made for an increased mineral exhibit, because the building is not large enough. I really do not know on what line an extension could take place.

President Hayward.—Is the building not to be enlarged ?

H. Piers.—I do not think so. Of course the style of the building will hardly admit of an extension, unless it be placed at the rear. I think the building will be completely filled at this year's exhibition, and what more can be done I don't know.

President Hayward.—It would be hardly fair to ask the government to extend the building.

H. Piers.—There is every willingness on the part of exhibitors to exhibit, but I think it is largely a matter of want of space. I am sure the mines department will do all it possibly can to make the exhibit a success on the lines in which it is now planned. I understand it was the intention of the government to have gone further into the matter if there was more space available.

President Hayward.—Under whose control is the building?

H. Piers.—The building was constructed by the exhibition commission, and it is now under the control of the mines department.

President Hayward.—If the building is too small, perhaps the society would do well to appoint a committee to wait on the government to express that view.

F. P. Ronnan.—It seems to me now is the time to get this done.

Election of Officers.

J. H. Austen, from the committee appointed to nominate officers for the ensuing year 1906-07, reported as follows:—

President—A. A. Hayward; *First Vice-President*—Charles Archibald; *Second Vice-President*—Dr. J. E. Woodman; *Secretary and Treasurer*—H. M. Wylde; *Editor and Librarian*—Harry Piers; *Council*—J. A. Johnson, Professor F. H. Sexton, Richard H. Brown, Dr. Henry S. Poole, George W. Stuart and B. F. Pearson; *Auditors*—F. P. Ronnan and Charles Starr.

On motion the report was adopted. Ballotting for the officers then took place, and the above officers were unanimously elected.

Constitution and By-Laws.

J. H. **AUSTEN**.—The draft of the new by-laws now upon the table was mailed to all members some time ago, and I understand that there have been no suggestions as to alterations. The committee has submitted a set of by-laws which I believe will be found satisfactory. I therefore move the adoption of the by-laws as they are now presented.

H. M. **WYLDE** seconded the motion, which passed unanimously.

Technical Education.

PRESIDENT HAYWARD.—You are aware that sometime ago we took up the subject of technical education, and for some cause it was dropped. The society recognizing the value of such a question to the province, decided at the last meeting to take up the subject again for the purpose of trying to persuade the government to assist by appointing a commission to investigate the subject, and, with that end in view, Professor Sexton has prepared a paper on the subject. To further assist the movement, we have decided that that subject should be the topic at this evening's dinner. We have succeeded in having Professor Richards of the Massachusetts Institute of Technology come here and speak tonight.

PROF. F. H. SEXTON then read a paper on "The Relation of Technical Education to the Industries." (Reproduced elsewhere) The paper was followed by a discussion.

On motion of W. C. **MILNER**, and R. H. **BROWN** it was resolved that President Hayward, Prof. Sexton, Dr. Woodman, Hon. Mr. Drummond, and Mr. Pearson be a committee to wait upon the government and ask it to take up the question of technical education.

Paper Read.

Phillip A. Freeman, chief engineer of Halifax Electric Tram-Co., read a paper on the 'Halifax Electric Tramway Plant and

Steam Engineering." (Reproduced elsewhere). The paper was followed by a discussion and a vote of thanks to the lecturer.

The meeting then adjourned until the following morning at 10.30.

Annual Dinner.

The society dined at the Halifax Hotel on the evening of 22nd March, 1906. A. A. Hayward, president, occupied the chair, and near him sat Premier Murray, Hon. W. T. Pipes (Commissioner of Public Works and Mines); Professor R. H. Richards, of the Massachusetts Institute of Technology; Professor E. MacKay, of Dalhousie College; President Hannah, of King's College; Dr. Thompson, of St. Francis Xavier College, and others. The dinner was the occasion of making a strong plea for technical education in this province, and the speeches bore upon that subject.

President Hayward proposed the toast, "The King," which was responded to by the singing of the national anthem. "The President of the United States" was responded to by singing "The Star Spangled Banner." In response to "Our Guests," President Forrest acknowledged the honor. He said: "I acknowledge your kindness in the toast you have drunk so heartily. I am very much pleased to be here and am deeply interested in this mining association, as I am in all associations connected with our province. The more energetically we conduct our work the better it will be for us. We have only commenced to realize and to develop the immense resources we have. The mining society of Nova Scotia deserves a great deal of credit for what it has done. In connection with the University of Dalhousie, of which 1 am the head, we have been trying to do something, and I hope our success and yours will go hand in hand.

PROF. R. H. RICHARDS, head of the Massachusett's Institute of Technology, then delivered an address on "The Relation between Technical Education and Industrial Progress." (See **Papers, page 27**).

Addresses on the same subject were also made by PROF. E. MACKAY, of Dalhousie College (see Papers, page 45), and PRINCIPAL SOLOAN, of the Provincial Normal School (see Papers, page 53).

DR. THOMPSON.—I have listened with a great deal of pleasure and profit to the learned address of Professor Richards especially as it concerns the great public welfare. The college with which I have the good fortune to be associated (St. Francis Xavier), has possibly more intimate connection with the great institution from which Professor Richards comes than any other college in these parts. Many of our professors have graduated from the Massachusetts Institute of Technology, and their work in our institution has served to enhance very much the respect which we have for that institution. The graduates from the institute go at their work as men entering upon their business, rather than in the manner which very often prevails in educational institutions where young men go to learn what others have to teach.

PRESIDENT HANNAH.—There is a very estimable tribe on the west coast of Africa, a tribe with which the English have had serious difficulty in the past—that is, the Ashantis. That tribe has a saying, a very old one, that was handed down from their ancestors: "Softly, softly, catch a monkey." Never be in a hurry about things. Now, possibly, that has been the policy of Nova Scotia in the past, but I hope it will not be in the future. We have heard something about the contentment of Nova Scotia, and perhaps with a certain amount of reason. The Japanese have made education a marvellous feature in their national life. In the interior of Japan I was corrected upon two matters by two Japanese who had never been outside of their country—one was as to the population of Ireland, and the other was with respect to Oxford university.

HON. G. H. MURRAY.—I desire to express my thanks to you and your society for the pleasure of being here to-night. I can only reiterate with others expressions of the enjoyment I have had in listening to the address of my friend Professor Richards, who has been correctly described as a notable engineer who is associated with one of the greatest technical institutes on this continent. I am glad to observe that the Mining Society of Nova Scotia has taken an interest in the important subject of technical education, because I assume that it was for the purpose of stimulating that subject that your society had invited Professor Richards to deliver the excellent addresses he has given us to-night. I felt that at first I should be here rather in the capacity of a listener. I never like to talk frankly unless I see where my frank talk is going to land me. I think my friend, the Hon. Mr. Pipes, who is more reticent than I am, thought it would have been better that I should have remained a silent listener, but I recognize the great importance of technical education to this province. I am not going to discuss it, because I think we can admit right now, that if technical education is of such importance to the people of Nova Scotia, the government should give some earnest consideration to the question. Now to be frank, the government of Nova Scotia has been considering the question. I think that Professor MacKay made a very fair statement to-night when he undertook in a general way to tell you what the Nova Scotia government has done for technical education in this province; what we have done with respect to mining education. True it has been limited, but it has been a wise expenditure of money. We have done something with respect to the agricultural college in the province which completely meets the requirements of that great class of our population. We have introduced domestic science and manual-training into the public schools of Nova Scotia, and we have not been totally remiss in discharging our duty in respect to technical education. But now the question arises, have we gone far enough, and if we have not, what can we wisely do in going further?

Now, I have felt—and I do not mind confessing this to you—that the first reason why the government of Nova Scotia has not dealt with the question of technical education two or three years ago, more fully and completely than we are dealing with it at this moment, was for a financial reason. We have got to be careful with our provincial funds. We were surrounded with great problems. We expended last year nearly $300,000 on education and yet we have not gone as far in the direction of general education as we should have gone. It is quite true that we might have gone further in the direction of the general education of the province. I felt that a very fair reason could be given why this question should be taken up by the federal government. Every argument to-night has been in the direction that technical education would develop the trade and commerce of this country. I have felt, and I have gone to the federal government with the case, that while under the British North America act, education generally, and the whole burden of education, has been placed on the provincial government, yet in respect to technical education, that education which is necessary for the development of trade and commerce, that the federal government should to some extent come to our assistance. We made out such a case, that I felt at one time they would be willing to fall in with the idea at Ottawa. I felt it would have been a wise policy for them to adopt; I felt it would have been an expenditure of money on the part of the federal government which would probably have been better than some they have undertaken. That is not my view alone. but the view of every gentleman who shouldered that responsibility in connection with provincial affairs.

I have anticipated a general discussion between the Province and the Dominion, and I propose to make technical education, so far as this province is concerned, a very important factor in that discussion. When we felt that the government was confronted with this question of technical education, I did not complain of it. I was glad to see two of the educational institutions in this province take up the question of technical education, and they took it up vigorously and on popular lines, and dealt with it in a measure which I felt sure would satisfy a want in that respect. I refer to the efforts made by Dalhousie and King's colleges. I said at the time, it perhaps would have been better if these educational institutions would take up, so far as engineering is concerned, mining engineering, mechanical engineering, and electrical engineering, and deal with them. I was confronted with three ideas: First, with the financial aspect of the question; second, with the idea that it might be education coming within the purview of the federal government; and third, that it was being dealt with by two of the great educational institutions in the province. If to-night I felt that these educational institutions would come to the government of Nova Scotia and say we are willing to place this burden upon the province, if, secondly, I could not convince the federal government that it was its duty to take up this question, and if, in the third place, we had the financial resources, I would take it up on lines which I believe would be very satisfactory.

Now my friend, Professor MacKay, in discussing this question, said he thought that it should be dealt with by a commission. I think the government of Nova Scotia has sufficiently considered this matter, and that it does not require a commission. Professor MacKay, himself, has made a statement here which will indicate the policy of the provincial government, and that is this (smaller, of course, I will admit), that the lines of the Boston institution will furnish a suitable model for Nova Scotia. We will erect a building on the lines of the agricultural college at Truro, following out the system of the Boston school of technology. That is the idea we have, provided we have the assistence, if our finances will permit of it, and if we cannot get the federal government to take it up.

I am very glad I am here to-night. I think your mining society is entitled to a great deal of credit, if for no other reason than that you have brought Professor Richards here, and that you have been the means of giving this audience the pleasure of listening to the presentment of the question at the hands of such men as Professor MacKay, Principal Soloan, and others. I have thoroughly enjoyed myself this evening as a guest of the mining society of Nova Scotia.

HON. W. T. PIPES (Commissioner of Public Works and Mines).— Our able, patriotic and progressive leader of the government mentioned my name in a manner which would lead you to suppose I was a conservative and obstructionist in the government of Nova Scotia. I wish to correct such an impression. It is well known to every person that I am the greatest radical in the government at the present time, and that I am now one of the few democrats "right up to the hilt" that are left in Nova Scotia. It would be very foolish for me to make a speech here this evening when I see on every side learned men, experts from the great institutions of learning—presidents and professors of colleges, doctors, principals, superintendants, and supervisors on every hand. I feel that when I am in company like this I ought to lend every man my ear and few my tongue. But I thank you, Mr. President and gentlemen of the mining society, for your kind invitation, and for bringing these men here. I have listened to their speeches with a great deal of pleasure and profit. In my opinion I have never heard better speeches delivered at any banquet that I have had the pleasure of attending for some time, than those I have heard to-night, because they have been eloquent and instructive. I agree with all that has been said.

I want to make this statement in reference to the government of which I am a member, that we are not afraid of debt so long as the money which we obtain for that indebtedness is expended in developing the resources of our country. And we believe that the development of the brain power of the young men and women of this country is one of the best resources that we can develop. We have to say to you that the credit of the province is very good, and so long as the credit is good and we can get the money, we do not intend to let our friends have an opportunity of trying a conservative policy. It is not necessary for me to say anything more here tonight. We know that the minerals of this province are vast and we know that they need development. When I first came into this government some years ago, the amount of revenue we obtained from a ten cent royalty on coal was less than $100,000; now it is over half a million. I think that is a fair criterion in that respect. We are glad to have the men we see around this board considering the question of technical education and the development of the mines and minerals of Nova Scotia, and whenever you devise and think out anything that will be for the advantage of the mines and mining interests of Nova Scotia we will be very glad to adopt it. With respect to a better survey of the minerals geologically, we feel that the work done by the Dominion government must be more particularly extended to Nova Scotia, and it is the intention of the government to take hold of that matter. We are willing to discuss it with the Dominion government and with the members of your society at an early day, and if we cannot make proper arrangements in that respect with the Dominion government, we will consider the matter so far as it is necessary, and I as a member of this government will be most glad to accede to your wishes.

MEETING OF 23rd MARCH.

The society resumed its meeting on 23rd March, 1906, at 10.30 a. m., with the president, Mr. Hayward, in the chair.

W. C. MILNER read a paper on "Reciprocity in Natural Products," which was followed by a discussion on the subject.

GEORGE W. STUART read a paper on "Shaft Sinking in Quicksands and Boulders." (Reproduced elsewhere.) A discussion on the subject followed.

PROF. J. E. WOODMAN read a paper entitled, "Close Incorporation and the Engineering Profession: an engineering trust," which was followed by a discussion. The matter was left to the council to deal with

W. C. MILNER gave the following notice of motion:—"Notice is hereby given that I will move at the next meeting of the society that it is competent for this society to discuss the question of markets for the sale of all the products of our mines and quarries."

A paper by FRANCIS WILLIAM GRAY on "Ankylostomiasis: Miners' Anemia," was then read by Dr. Poole. (Reproduced elsewhere.)

The meeting adjourned.

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CONSTITUTION AND BY-LAWS OF THE MINING SOCIETY OF NOVA SCOTIA.

ACT OF INCORPORATION.

(EXTRACT FROM CHAPTER 231. 3 EDWD. VII.)

1. The object of the society shall be to mutually benefit and protect its members by facilitating the interchange of knowledge and ideas, and by taking concerted action upon all matters affecting or relating to the mining industries of the province, and generally to promote the said industries by all lawful and honourable means.

2. The society may acquire and hold such lands and property as are necessary to carry out the objects and purposes for which incorporotion is sought; provided the annual value of the real estate held at any time for the actual use of the society shall not exceed five thousand dollars.

3. The society may make such by-laws, not contrary to law as it deems expedient for the administration and government of the society.

4. The affairs and business of the society shall be managed by such officers and committees, and under such restrictions touching the duties and demands of such officers and committees as may be prescribed by by-law.

5. The head office of the society shall be in the city of Halifax aforesaid, or in such other place as may from time to time be determined by a vote of two-thirds of the members of the society.

BY-LAWS.

(Adopted 22nd March, 1906.)

I.

MEMBERSHIP.

(a) The membership of the society shall comprise, (1) members, (2) honorary members, (3) student members.

(b) *Members* shall be persons actively interested in the ownership, operation, or study of the useful minerals of the province, or the manufacture or distribution of machinery or or other material used in winning these minerals.

(c) *Honorary members* shall be persons eminent in professions associated with mining, or in the history of the mineral development of the province. They shall be entitled to all the privileges of membership except voting and holding office.

(d) *Student members* shall be students in technical schools in the province at which the mining profession is taught, or Nova Scotian students attendant upon technical mining schools outside the province. They shall be entitled to all the privileges of membership except voting and holding office. No member shall be eligible to membership in this class after he ceases to be a student as above described.

II.

ELECTION OF MEMBERS.

(a) Any candidate for membership as member or student member must be proposed in writing by at least two members, such proposal to be submitted to the council; must be approved by a vote of two-thirds of the members of the council present at any meeting of that body; and must be subsequently elected by by not less than three-fourths of the votes cast at any regular or annual meeting. Votes must be cast by means of ballots; and the scratching out of a name upon the ballot by the voter shall be equivalent to a negative vote for that cannidate.

(b) Honorary members must be proposed in writing by at least ten members, and shall be elected as above, except that nine-tenths of the votes cast by members shall be necessary to election.

(c) Student members may be elected members at any time by a majority vote of the council at any meeting of that body.

(d) Every person elected member shall be elected member shall be given the privileges of membership upon payment of his first dues.

Every person elected honorary or student member shall be given the privileges of membership upon election.

(e) If any person elected a member does not, within sixty days after notice of his election, accept the same and pay his first fees, his election may be cancelled at the discretion of the council.

(f) A copy of section (d) of this by-law shall be printed upon the nodification of election.

III.

DISCIPLINE.

(a) Any member guilty of conduct prejudicial to the dignity or interests of the society may be expelled from such membership, and shall thereupon forfeit all proprietary rights in the assets of the society.

(b) Upon receipt of a complaint in writing signed by at least five members of the society, alleging cause why a member should be expelled, the council shall advise such member in writing of the charge so preferred, and he shall have a period of thirty days within which to make answer. Should the council after inquiry not consider the answer so given satisfactory the matter shall be referred to the next general meeting of the society. Sixty per cent. of the votes cast at said meeting of the sociefy shall be necessary to expel such member.

IV.

DUES.

(a) The dues of members shall be ten dollars per annum, payable in advance at the annual meeting of the society. Any one elected member after July 1st shall be liable for half the the dues for the current year.

(b) There shall be no dues for honorary or student members.

V.

OFFICERS.

(a) The executive officers of the society shall be a president, two vice-presidents, a secretary and a treasurer ; and in addition six members at large, who shall, with the foregoing officers, constitute the council of the society. The senior officer present at any regular or special meeting of the society shall act as chairman.

(b) Past presidents shall be *ex efficio* members of the council for two years after retirement from the office of president.

(c) Members are eligible to office who, at the time of the annual meeting, are in good standing and not in arrears for dues.

(d) Five members of the council shall constitute a quorum.

(e) The duties of the officers shall be those usually pertaining to their respective offices, together with such other duties as may from time to time be prescribed in by-laws.

(f) Vacancies in any office occurring through any cause, may be filled by vote of the council until the next annual meeting. No such an appointment, however, shall disqualify the member for election at the annual meeting.

VI.

MEETINGS.

(a) The annual meeting of the society for the election of officers and the transaction of other business, shall be held in city of Halifax, N. S., on some day or days between January first and April first, the date to be at the discretion of the Council. A preliminary notice of the date of this meeting shall be mailed by the secretary to each member, of whatever class, not less than six weeks previous to the proposed date.

(b) Other regular meetings may be held at any time and place upon order of the council, notice of such meeting having been mailed by the secretary to all members, of whatever class, not less than fourteen days previous; and a special meeting for business or other purposes shall be ordered by the council upon the written request of ten member, not in the council.

(c) At any special meeting, the subjects for which the meeting is called must be printed in the notice concerning the meeting. Action at such meeting affecting the policy of the society, shall be restricted to the subjects mentioned in the notice.

VII

ELECTION OF OFFICERS.

The council shall prepare a list .of nominations for the offices of president, two vice-presidents, secretary, treasurer and six members of the council, and shall cause the list to be posted six weeks before date of the annual meeting to each member. A member may add other names upon such list, and return the same to the secretary within thirty days of the annual meeting. The secretary shall then prepare a revised list, including every nomination for the several offices, and shall mail to each member a copy of the same twenty days previous to annual meeting with a blank ballot. Members shall fill out the ballot with names selected from the revised list, and lodge the same, folded and sealed, with the secretary on or before the date of the annual meeting. A printed copy of this provision of the by-laws shall accompany each list of nominations prepared and sent out by the council.

VIII.

AUDITORS.

At each annual meeting two auditors shall be elected by majority vote, who shall inspect and audit the financial statement of the treasurer before presentation at the next annual meeting. Auditors shall be chosen from members not in arrears for dues, who hold no other office in the society.

IX.

CHEQUES.

The president, or in case of absence or disability, the acting president, shall countersign all cheques issued by the treasurer in payment of bills contracted by the society.

X.

ANNUAL MEETING.

(a) At the annual meeting of the society the following shall be the order of business:

Minutes of preceding annual meeting.
Minutes of preceding meeting.
President's address.
Report of secretary.
Report of treasurer.
Report of librarian.
Report of council.
Unfinished business.
Reports of standing committees.
Reports of special committees.
Reading of papers.
Miscellaneous business.
Election of members.
Election of officers.

(b) The order of business at any meeting may be changed by vote of a majority of members present.

XI.

PUBLICATIONS AND LIBRARY.

(a) The council shall have the power to publish yearly all papers presented at the meetings of the society, together with the discussions on the same; or such papers and discussions as the council shall judge worth of publication.

(b) Neither the council nor the society shall officially approve or disapprove any statements or opinions expressed in such papers or discussions; nor does the society assume responsibility for such statements or opinions.

(c) The council shall have power to appoint each year a librarian, who shall care for the society's library. He may also act as editor of the publications the society. The council shall have power to vote remuneration for his services.

XII.

AMENDMENTS.

(a) By-laws one to six inclusive, and twelve, may be amended at any annual meeting by a two-thirds vote of all the members present:—

Provided that the notice of such proposed amendment shall have been given in writing at a meeting held not less than one month previous to said annual meeting; and *provided* that the amendment so proposed, together with the original by-law, shall have been printed and mailed to all members not less than twenty days previous to the annual meeting.

(b) By-law seven to eleven inclusive may be amended by vote of two-thirds of all members present at any meeting of the society:—

Provided that notice of the proposal of such amendment shall have been given in writing at a meeting held not less than one month previous to the one in which a vote is taken on the amendment; and *provided* that the secretary shall have mailed to all members a copy of the proposed alteration, together with the original by-law, at least twenty days before the vote.

(c) Except by-law ix., these by-laws shall not be subject to temporary alteration or suspension.

TN Mining Society of Nova Scotia
1 Journal; being the transac
M72 tions of the society
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